MAY 1958

Power Engineering

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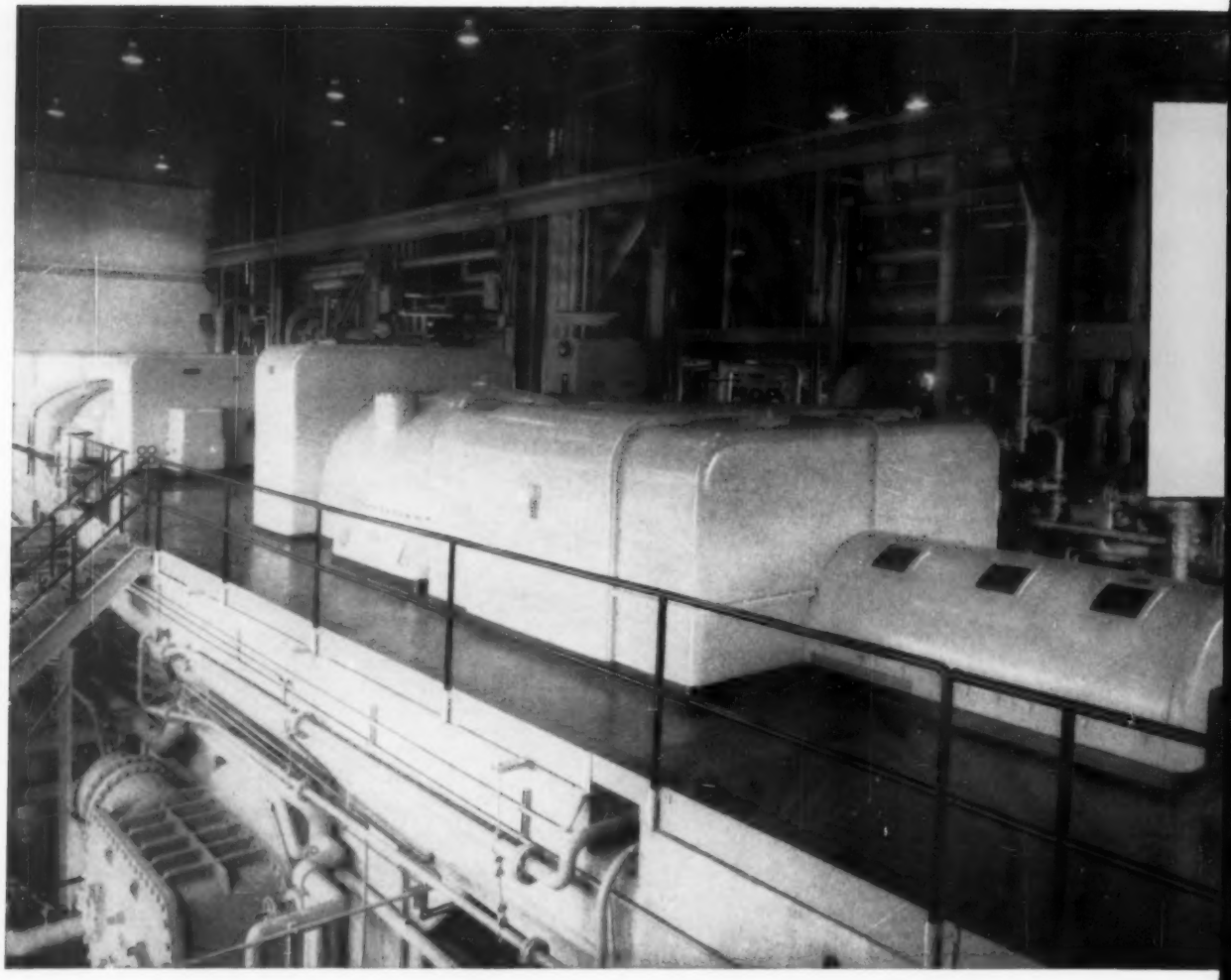
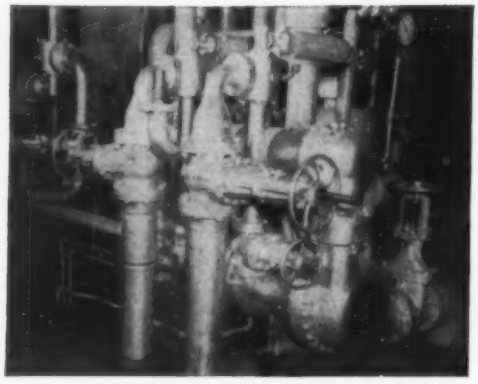
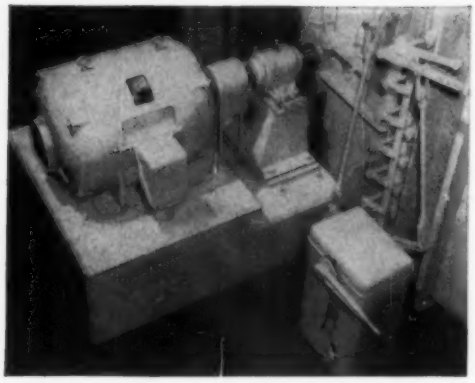




An Elliott twin two-stage steam jet ejector serves the condenser. Ejector is equipped with air leakage meter.



The forced-draft fan is driven by an Elliott C-W 150-hp, 1160-rpm motor.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS
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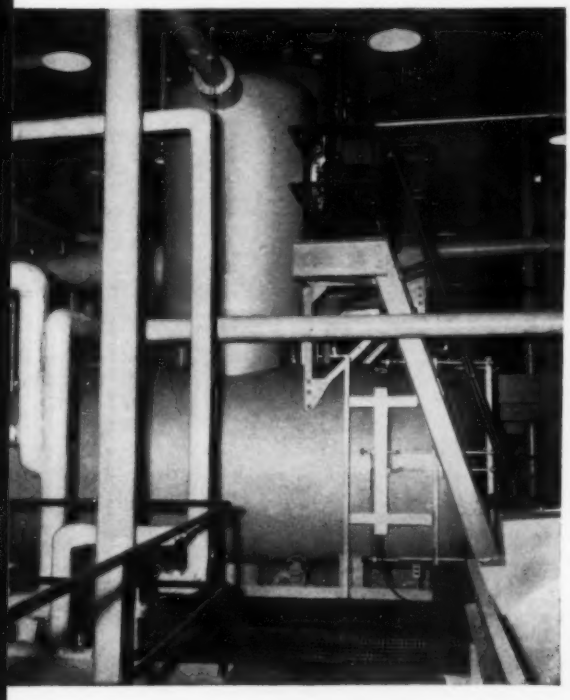
06-3

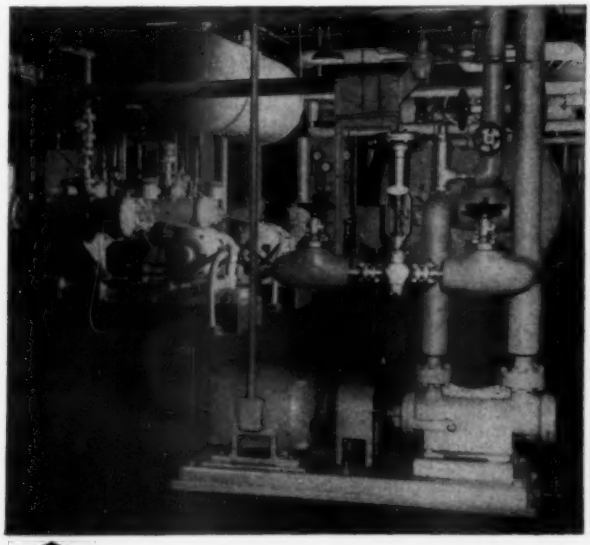
SECOND ELLIOTT UNIT installed at CARIBOU . . .

When Maine Public Service Company decided to expand the generating facilities of their Caribou Power Center, they had the benefit of four years of experience with Elliott equipment to guide them in the selection of turbine generator, condenser and auxiliaries for Unit No. 2. The equipment shown on these pages is all installed in Unit No. 2, and is evidence of the satisfactory performance of the Elliott machines in Unit No. 1.

Complete information on Elliott equipment may be obtained from our nearest District Office, or from Elliott Company, Jeannette, Pa.

This view of the turbine room shows in the foreground the No. 2 12,650-kw Elliott turbine-generator unit. Underneath it may be seen the Elliott 11,000-sq-ft surface condenser serving this turbine. Ejectors are behind the generator. In the left background is the 7500-kw Elliott turbine-generator unit installed in 1950.





The photograph above shows two air compressors driven by Elliott C-W 75-hp, 1765-rpm motors. In the foreground, the fuel oil booster pump is driven by a 15-hp, 740-rpm motor. Condenser is seen in the background.

The Elliott 128,010 lb-per-hr deaerating feedwater heater consists of a vertical heater mounted on a horizontal storage tank. It is located at an elevation near similar No. 1 unit.

For more data circle 501 on Post Card

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for

CHEMICAL PLANTS

and

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Write for bulletins. Dept. 24A-BPE

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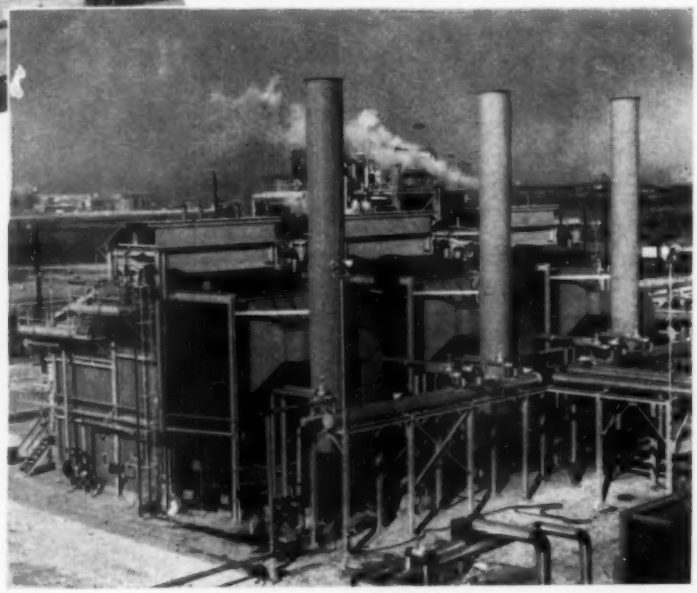

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

LATEST COMPUTING WONDER in the power field is a device which will combine a complete computer with generation control elements. General Electric will build it for Commonwealth Edison Co. It will measure the moment-by-moment use of electricity by the company's 1,940,000 customers in the Chicago area, and simultaneously regulate the output of dozens of generators to meet the exact demand.

At the same time, it will also determine which of the generators then in operation best fit the dollars-and-cents economics of production. By remote control, it will step up or lower the output of the individual machines. This is done, of course, on the basis of information fed into the computer in advance — information which the company is constantly revising to meet changing conditions.

With its ability to make intricate calculations, the device almost instantaneously will translate this "knowledge" into the correct answer and then "tell" the generators what to do.

SCANNING THE RECORD for company operations in 1957, as handsomely set forth in the pages of the annual reports, brings out many an interesting comparison or facet.

American Gas & Electric in 1957 set a new record for a private utility system, by selling 21.4 billion kwh. Operating revenues were $284,000,000.

Detroit Edison had a power output for the year of 13.79 billion kwh. Gross revenues were $251,026,163, or 6 per cent higher than for 1956. The company spent $81,000,000 in construction, will spend $75,000,000 this year.

Allis-Chalmers Manufacturing Co reports sales and other income in 1957 of $537,191,443. It was $551,592,589 in 1956. On the current "readjustment in business conditions" the company comments: "We find some obvious continuations of the downward trend and others with reason for moderate optimism. At present these factors seem to be about in balance."

General Electric management is "making its plans on the assumption the nation will resume its long-term growth within the year, following the present period of adjustment." In 1957, the company's sales reached a record $4.3 billion, a 6 per cent increase over 1956. Twenty-six percent of this total was in heavy capital goods, including turbine generators, large electric motors, transformers and switchgear. Net earnings in '57 stood at $247,851,871, an increase of 16 per cent over 1956.

Sylvania Electric Products had record-breaking sales in 1957, predicts another smash year for 1958. Sales volume last year was nearly $343,000,000, is expected to approach $400,000,000 this year. On the present economic state: "There is every indication that the current decline in

Another Associate Editor Wanted for POWER ENGINEERING

ARE YOU the man? We have another opening in the editorial staff for a mechanical engineering graduate, between 30 and 45, with broad steam-electric power plant operating experience in utilities or industry or both. Holding of PE license would be an advantage, as would some knowledge of diesel, hydro, refrigeration and compressed air.

The man we want must have a good personality, like to travel some, and to investigate new developments over the country. He should be able to write, but previous *editorial* experience is not required.

If you are interested and meet these specifications, send a photograph and résumé of your experience to the Editor, POWER ENGINEERING, 308 East James Street, Barrington, Ill.

our economy is only short-term and that the second half of 1958 will bring an upturn."

Westinghouse's sales billed in 1957 passed the two billion mark for the first time. Atomic power field sales nearly doubled those in 1956. Net income for '57 amounted to $72,652,000, compared with $3,492,000 earned in 1956. Looking ahead: "We entered the year with a very substantial backlog of orders for electrical generating equipment, but with backlogs for industrial products lower than a year earlier. Economic predictions indicate that the market for consumer products will improve somewhat."

Total sales of Cleveland Electric Illuminating Co in 1957 reached $118,700,000, up 6.3 per cent from 1956. Expansion program for 1958 has been set at $65,000,000, an all-time high for the company.

Air Reduction Co had increased sales of 12 per cent in 1957. Net income increased 5 per cent. "We are confident that progressive growth lies ahead for the American economy."

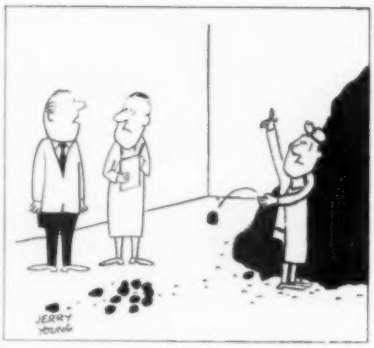
PERSONALS: Westinghouse has awarded $10,000 to engineers Robert C. Dickinson and Russell E. Frink in recognition of their inventions which greatly improved protection devices for electrical distribution systems. They shared the award equally.

Carl W. Bernhard has been appointed assistant to the chief engineer of Allis-Chalmers' Steam Turbine department. He has been second in command of the company's Motor and Generator department since 1947.

Edwin H. Krieg, vice president and consulting engineer of Stone & Webster Engineering Corp, has been elected a director.

N. J. MacDonald, president of the Thomas & Betts Co of Elizabeth, N. J., has been elected chairman of the National Electrical Week Committee. He succeeds Merrill E. Skinner of Union Electric Co, who has led the development of National Electrical Week for the past three years. Dates of the Week for 1959 are February 8–14.

Cummins & Barnard, Inc, engineering firm in Ann Arbor, Mich., are now occupying their new office building at 2058 South State Street.



"No, no . . . That's not how we inventory our coal pile!"

S IS FOR SUMMER SCHOOL. There are interesting opportunities open at Massachusetts Institute of Technology, and at Manhattan College. MIT has two special 2-week programs designed for research workers, development engineers and teachers. One is on Modern Developments in Heat Transfer, to be given July 8–18; the other is on Thermodynamics for Engineers and Chemists, to be given June 23 through July 3.

Manhattan College's Civil Engineering Dept (New York City) will offer a one-week course on Bio-Oxidation of Organic Wastes, June 16–20. Emphasis will be placed on bio-oxidation fundamentals as applied to several wastes from industries including pulp and paper, pharmaceutical, canning, and chemical.

SOUTHWESTERN SPECIAL is the American Society for Metals' Exposition and Congress, May 12–16 at Dallas, Texas. This is the first time the Society has staged a program for the region. There will be 29 scientific papers, 250 exhibitors in the exposition. ASM now rates the South and Southwest as a metal-working area well ahead of the West and second only to the Northern states.

Another unusual meeting on the schedule just ahead is the World Assembly of Engineers and Architects, Friends of Israel, which will be held in Israel May 29 to June 9. Theme is the role of technology in the development of Israel. Among American engineers and architects participating as speakers are Philip Sporn, president of American Gas & Electric; Louis Kahn, professor of architecture at Yale.

RUSSIAN SCIENCE gets a new channel into English-speaking countries, through the Pergamon Institute. This is a non-profit foundation which has recently been formed in Washington, D. C., and is now being formed in London, for the purpose of making available to engineers, doctors and scientists, the results of technological and medical research and development in the Soviet Union and other countries in the Soviet orbit.

Over 100 scientists of international standing from many countries will support and help supervise the affairs of the Institute. Joint presidents of the board of governors are Detlev W. Bronk and Sir Robert Robinson. Executive director is Captain I. R. Maxwell, M.C.

Since only about 2 per cent of American and British scientists can read Russian, the extensive translation program being undertaken by the Institute will fill a basic need. Institute services are available to individual scientists, government departments, engineers, learned societies, trade associations, doctors. The Institute's New York address is 122 E. 55th Street (New York 22).

POWER ABROAD: World Bank has made a $21,000,000 loan to the Philippines for the construction of a hydroelectric project at Binga, on the island of Luzon. Work includes a dam and a water storage on the Agno; also an underground generating station of 100,000-kw capacity. Power lines will run 125 miles south to deliver electricity to Manila, as well as to other provinces. Work has already been started on the project, and completion is scheduled for 1960.

Belgium plans construction of a 2,850,000-kw hydroelectric station at Inga (lower Congo), between Leopoldville and Matadi, Belgian Congo. Station will produce electricity at 0.13 cents or 1.3 mills per kwh, is expected to be in service by 1964.

In Australia, the British company, National Free Piston Power, Ltd, will supply a power plant for Zinc Corporation at Broken Hill. Installation will consist of three National GS.34 free-piston gasifiers, and one Brush expansion gas turbine direct coupled to an Oerlikon rotary air compressor.

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De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

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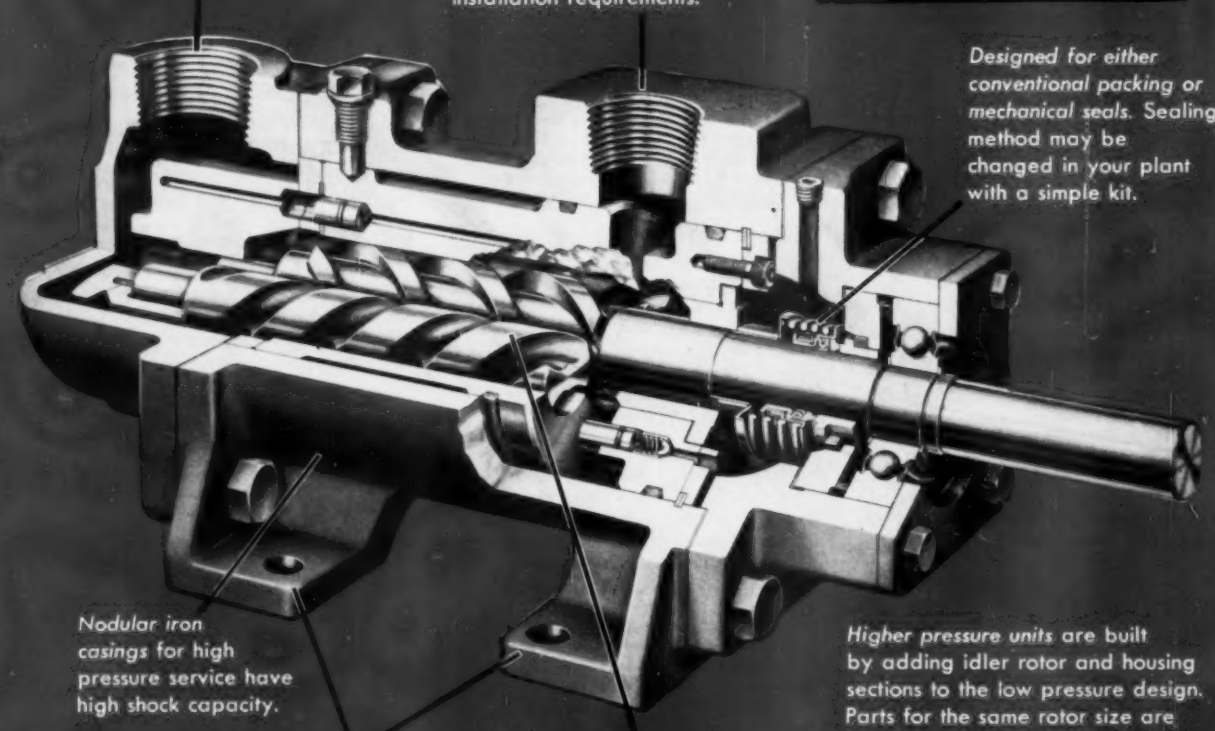

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.

Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.

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Any position mounting is possible without factory modification.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

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WHAT THEY TELL US

▶ **R. E. DRISCOLL** of Texas Butadiene & Chemical Corp has an answer to that problem of holes plugging up on the boiler feed line inside the boiler, which a reader raised in this department in March (page 6). Driscoll advises:

> Regarding the matter of the scale deposition on the outside of the feed line holes: this problem may be caused by having the feed line above the average water level of the steam drum.
>
> I should like to suggest to your reader that he lower the level of the feed line to two or three inches below the water level. If he has already done so I should like to suggest that he increase the total perforation area of the feed line to three to four times the cross-sectional area of the feed line.

▶ **START-UP ENGINEER,** his very special role and responsibilities, and his relation to construction problems, have very naturally come into focus in POWER ENGINEERING through the publication recently of the articles by J. H. Hunnicutt. Writes A. Darby Jones, mechanical engineer with the Tampa Electric Co, Florida:

> J. H. Hunnicutt's series of articles on the initial operation of new power plants are stimulating and thought-provoking. I believe the power industry would benefit substantially from the publication of these articles in book form.
>
> The abilities of the start-up engineer are often not exploited to the fullest possible extent, due to the lack of understanding of his functions and objectives, on the part of the construction and operation people. He is on a particular job for such a short time that it is difficult for him to educate those of whom he requires coöperation, to the value of his services and the importance of their coöperation. Such a book should help to solve this problem.
>
> Mr. Hunnicutt's articles are written from the viewpoint of the start-up engineer, and if read by construction and operation people, should instill greater appreciation and coöperation on their part. However, to encourage these people's interest in reading such a book, it will be necessary that more recognition be given the part played by the construction and operation people.
>
> I have known effective and ineffective start-up engineers. All have been technologically capable men. Their effectiveness has been directly related to the degree of their knowledge, understanding, appreciation and acknowledgment of the contributions made by and the problems of the construction and operation people.

Hunnicutt's articles are being reprinted. If you would like to have a set, write The Editor, POWER ENGINEERING.

▶ **IF YOU WORK** with hoists for a mining operation, you'll be interested, as we were, in this bit from the Brown Boveri *Review:*

> Progress . . . has made possible the use of automatic installations capable of raising up to 25 t at speeds of 16–21 m/s which, for such machines, represents the respectable power of about 5000 kw. By means of accurately timed schedules and by taking full advantage of the capacity of the plant, up to 850 t hourly can now be raised. Furthermore, this modern equipment enables up to 240 miners to be carried up and down during shift changes.

Brown Boveri points out that to turn the cages around in the shortest possible time, masses corresponding to 150 t have to be accelerated smoothly, then retarded and accurately brought to rest. Also, astonishingly enough, the loss of one second per trip represents a loss in production of about 1 per cent!

▶ **MEET THE ENGINEER,** the weekly radio program sponsored by the Philadelphia Section of AIEE, celebrated its fifth birthday on April 1. Tom MacCauley, chairman of the Section's radio committee, tells us:

> All of this radio time was provided free of charge as a public service by the radio station, and I received no monetary return. During this five-year period we have not missed a program nor changed the title of the subject or speaker from those listed on the advance program guide.
>
> The program started as our answer to the question, What is an engineer and what does he do? By weekly broadcasts over the local FM and AM station WFLN, Meet the Engineer has sponsored discussions by leaders of engineering describing the impact of engineering on the present and the future. By making use of tape recordings, it has been possible to hear from engineering personalities from India, Germany, France and Britain, in addition to prominent men in the United States.
>
> The goal of this communication program was especially aimed at awakening the interest of eligible high school students, parents, and people responsible for vocational guidance. The development of the young engineer after graduation, his role in society and the importance of his contribution to the progress and security of the country, as well as his own well-being, were thoroughly discussed.

Congratulations are certainly in order to the Philadelphia Section for an outstanding job of public relations. We take pride in the fact that Andrew W. Kramer, until recently Editor of POWER ENGINEERING, and now Editor of ATOMICS, has given several of the Meet the Engineer talks, and has also helped to arrange a number of the programs. Andy is continuing this work.

▶ **FINDING FRIENDS** everywhere is one of the rewards of editorial work on POWER ENGINEERING. This note reached us the other day from a reader in New Hampshire:

> I am a private consulting engineer, after having been many years with Stone and Webster. I highly appreciate your magazine and find it helpful. Please continue sending it to me.

Thank you, New Hampshire.

▶ **PONDERING** what articles in POWER ENGINEERING in 1957 did him the most good, Reader E. F. F. from Maryland singles out these three:

> St. Joe Paper Gets New Water by Long Distance, May issue, page 61
>
> How Non-Destructive Testing Aids Power Station Maintenance, March issue, page 57
>
> Single Phasing — What It Is, What To Do About It, March issue, page 74.

"Oh my yes — you're still required to push the proper buttons!"

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

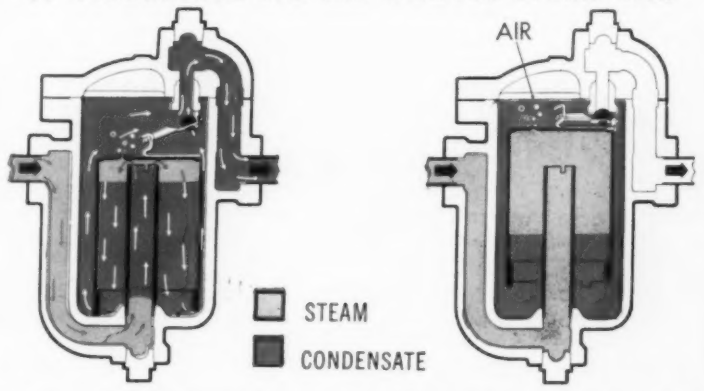
A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8107 Maple Street
Three Rivers, Michigan

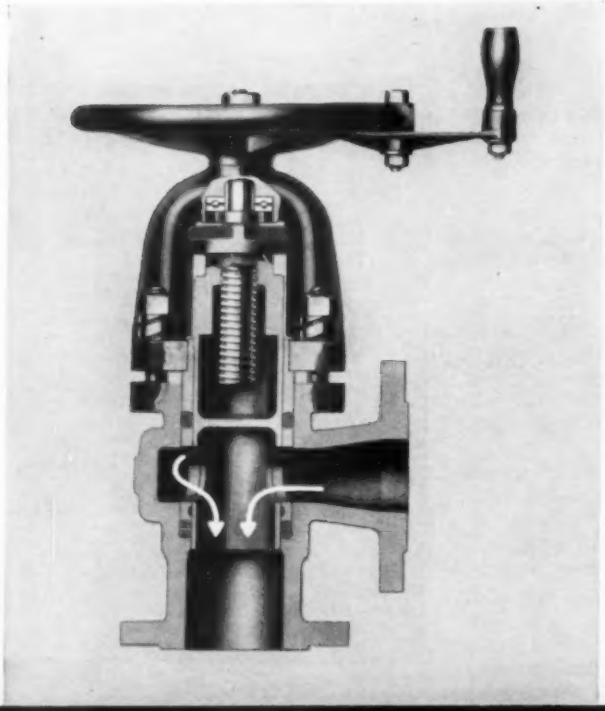
ARMSTRONG STEAM TRAPS

For more data circle 504 on Post Card

These YARWAY VALVE DESIGNS

YARWAY SEATLESS

Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features —laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.



FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.

FOR HIGHER PRESSURES

USED IN OVER 15,000 BOILER PLANTS

serve every boiler blow-down need

■ Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).

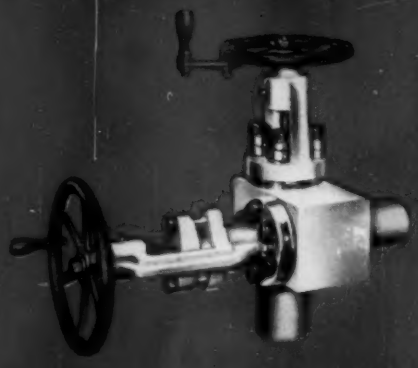
• Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.

• Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.

• Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.

• Yarway Hard-Seat Blow-Off Valve for pressures to 2500 psi. Straightway valve shown. Angle available. Welded (shown) or flanged connections. See Bulletin B-434.

• Yarway Hard-Seat—Seatless Bolted Tandem Blow-Off Valve. Hard-Seat is the blowing valve, seatless is the sealing valve. Available in any combination of connections. For pressures to 1500 psi. Hard seat-hard seat tandems for pressures to 2500 psi. See Bulletin B-434.



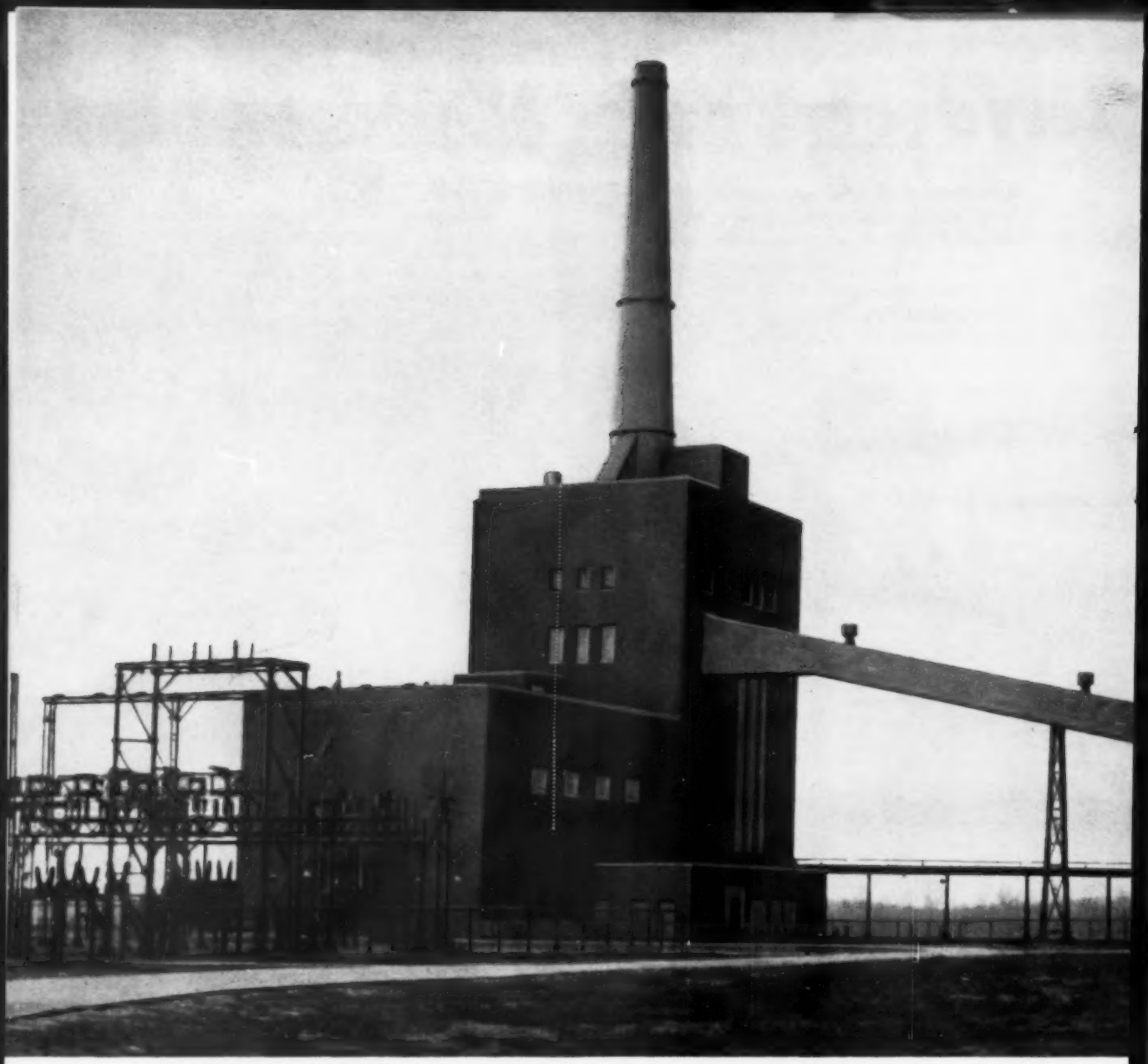
• Yarway Unit Tandem Blow-Off Valve. Combines a hard-seat blowing valve and a seatless sealing valve in one-piece forged steel body for boiler pressures to 1500 psi. For pressures to 2500 psi, two hard-seat valves are combined. See Bulletin B-434.

LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

blow-off valves



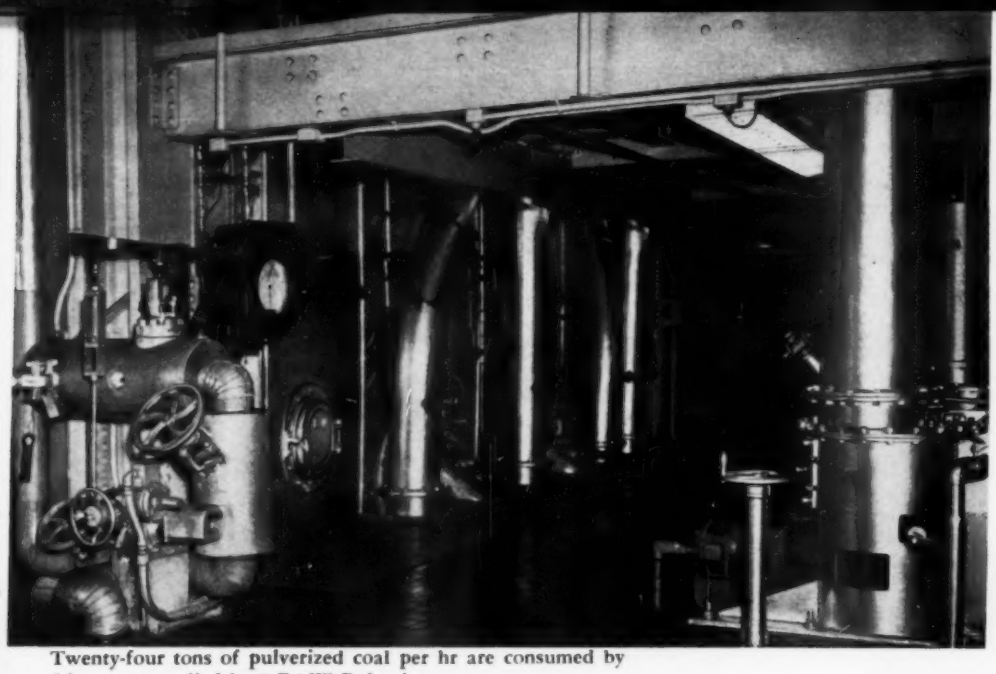
High Availability of B&W Boiler Brings

MORE LOW-COST POWER

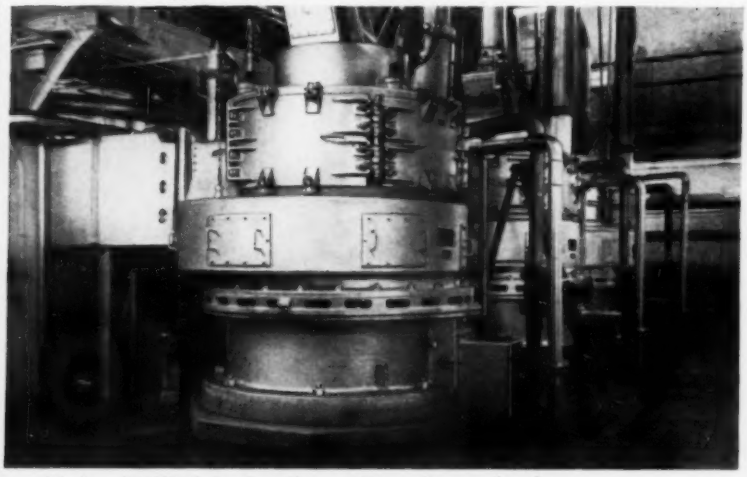
"Excellent availability and performance." After two years of operation, this is the report on the B&W Radiant Boiler purchased by the Southern Indiana Gas & Electric Company. The unit is on the line at the Culley Station near Evansville, where it provides more low-cost power for the growing area.

One major reason for the boiler's low operating and maintenance costs is the clean, dry steam assured by B&W Steam Separators. This keeps the turbine on the line for longer periods between cleanings and maintains higher turbine efficiency. Other important values include those made possible by B&W Pulverizers, which handle coal as received . . . wet or even iced . . . thus minimizing the danger of shutdown or loss of capacity. Pulverizers also grind coal to the specified fineness, thus assuring prompt ignition and complete combustion.

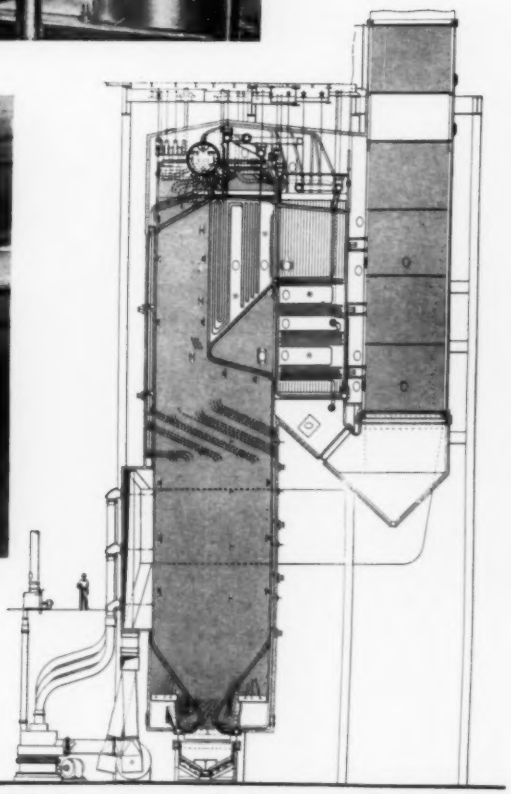
Advantages of B&W Boilers in central station operation are a result of B&W engineering advances in the development of economical energy, supported by nearly a century of steam generating experience.



Twenty-four tons of pulverized coal per hr are consumed by 6 burners supplied by 3 B&W Pulverizers.



Modern B&W Pulverizer System. Ease of operation is an outstanding feature of the B&W Pulverizer since the entire system automatically proportions the primary air and fuel, utilizing only one damper to accomplish load changes.



B&W Radiant Boiler at the Southern Indiana Gas & Electric Company's Culley Station has steam capacity of 437,000 lb per hour at 1290 psi at superheater outlet and 950 F. Designed pressure 1450 psi. Net generating unit capability 44,000 kw. Consulting engineers: Commonwealth Associates, Inc.

TO INDIANA

Important, too, for Southern Indiana Gas & Electric is B&W's national network of plants and engineers. Progressive electric companies and their consulting engineers continually turn to B&W research, development, engineering, and design for assistance and advice. This pool of knowledge is available to help you meet your central station requirements. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-857-CS

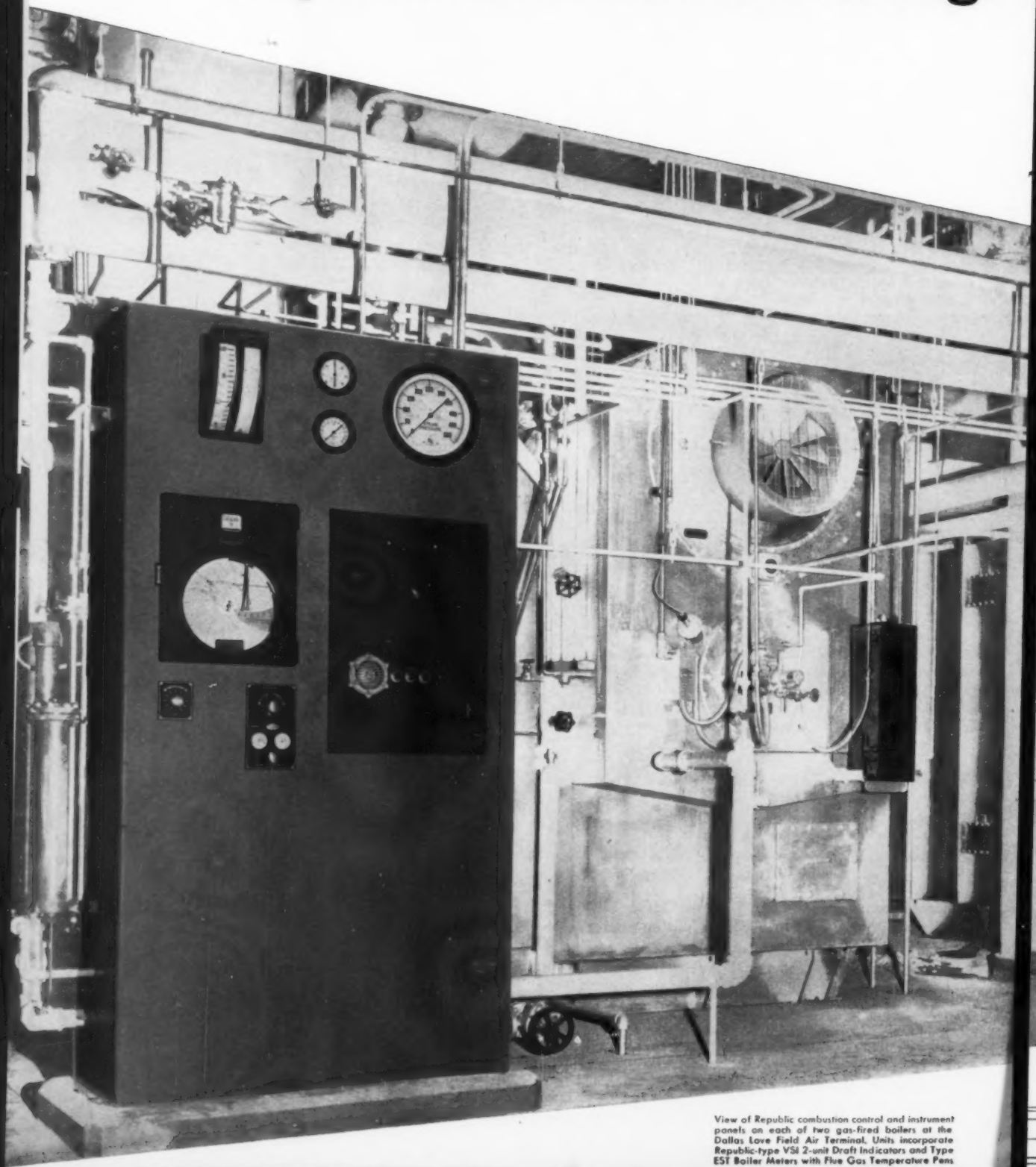
BABCOCK & WILCOX

BOILER DIVISION

For more data circle 506 on Post Card

ANOTHER REPUBLIC ACHIEVEMENT!

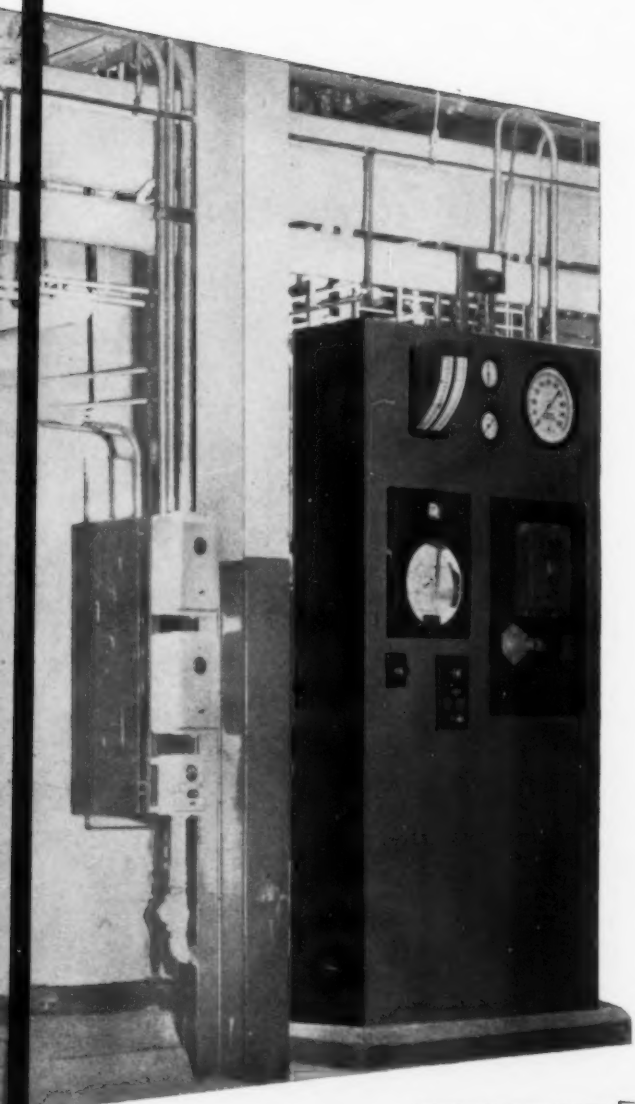
Republic Controls on Package



View of Republic combustion control and instrument panels on each of two gas-fired boilers at the Dallas Love Field Air Terminal. Units incorporate Republic-type VSI 2-unit Draft Indicators and Type EST Boiler Meters with Flue Gas Temperature Pens

Boilers Regulate "Indoor Weather"

. . . at Dallas' new Love Field Air Terminal



Complete Republic combustion control includes such features as on/off and modulating operation, instrumentation and flame failure control. This type of system operates two 15,000 lbs/hr package boilers, which supply 235 psi steam to centrifugal refrigeration compressors for the Terminal's air conditioning.

Republic's modern control designs are right at home in this $8,000,000 air terminal, which also features such innovations as touch control automatic doors, two-way moving sidewalks and carefully regulated "indoor weather". The new Love Field Air Terminal is truly one of the most modern in America.

Advanced-design combustion controls, based on Republic's experience in plants of all sizes—from package boiler installations to large central station units—are your best guarantee of premium performance from your major equipment. A Republic engineer is ready to help with your instrument and control planning. Republic sales offices are located in principal cities throughout the U.S. and Canada.

REPUBLIC
FLOW METERS CO.

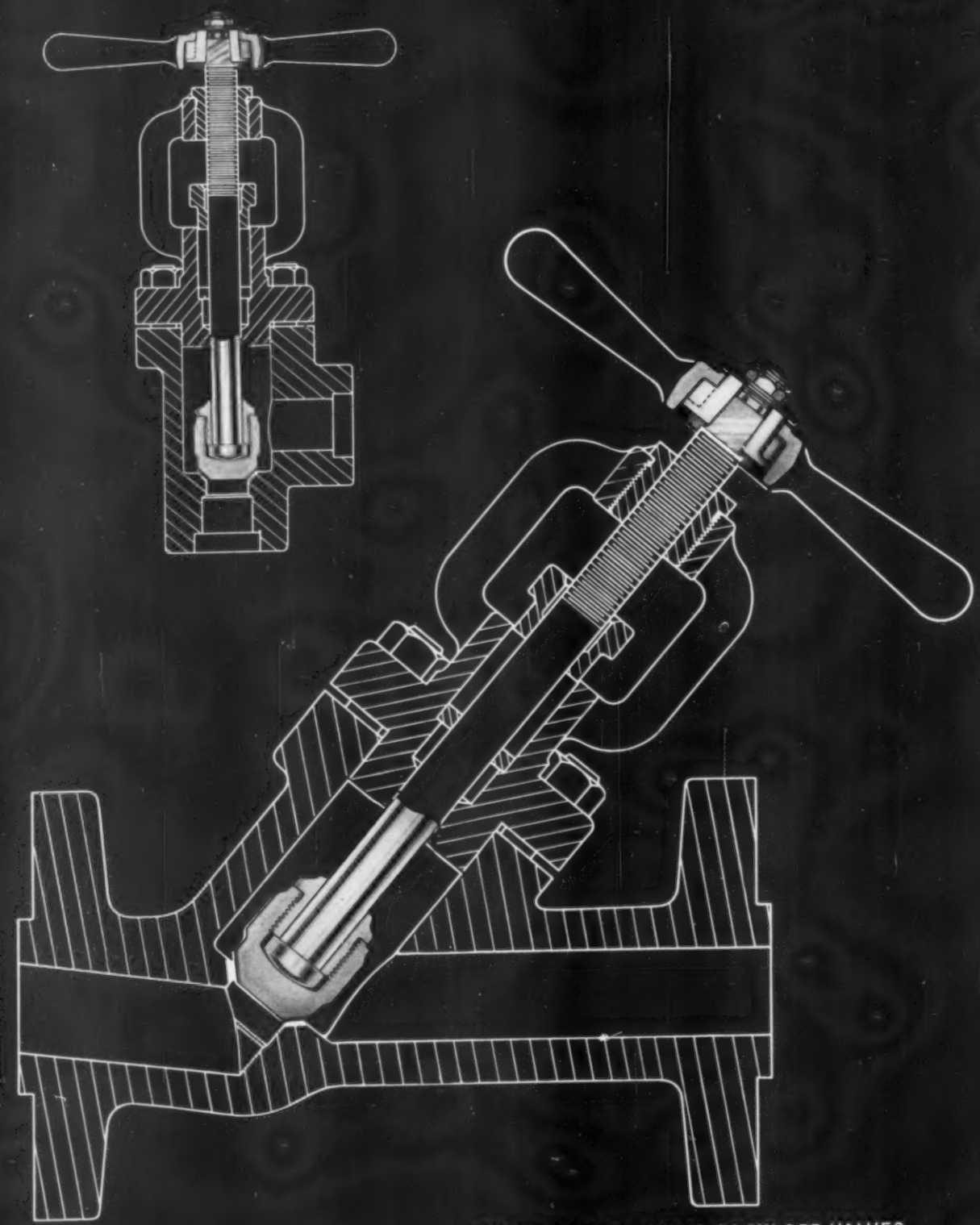
Subsidiary of ROCKWELL MANUFACTURING COMPANY

2240 DIVERSEY PARKWAY • CHICAGO 47, ILL.
In Canada:
REPUBLIC FLOW METERS CANADA, LTD. -TORONTO

Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

DALLAS LOVE FIELD AIR TERMINAL

Associated Architects: Broad & Nelson; Jack Corgan, Dallas
Mechanical Engineers: Zumwalt & Vinther, Dallas
Combustion Controls & Instruments: Republic Flow Meters Co., Chicago



EDWARD FORGED STEEL BLOW-OFF VALVES

What's New from Edward Valves

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Edward Drop Forged Blow-off Valves

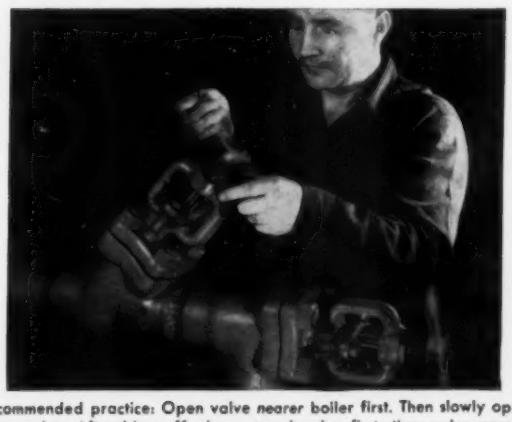
. . . the first—and still the newest!

Fifty years ago, when boilers operated at 250 lb sp the first really efficient means of blowing-down was with "new" Edward blow-off valves. Today, with pressure in the 1800-2600 lb range and with water temperatures sometimes exceeding 600 F, corresponding improvements in Edward blow-off valves have been effected. For example, today all Edward blow-off valves have integral Stellite seats and Impactor* easy closing handles.

All over the world, high temperature-pressure steam power stations rely on these Rockwell-built Edward blow-off valves. The reasons are basic. Edward valves are simple and rugged in design, with no "trick construction." They operate easily, stay tight, need very little maintenance. If parts replacement is ever necessary, repairs are easier and less expensive than with any comparable valve.

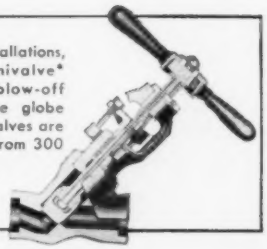
The ASME Power Boiler Code requires steel valves wherever boiler drum pressure is above 200 psi . . . but, because blow-off service is severe at any pressure, operators of lower-pressure plants also have found it most economical to standardize on Edward valves.

Catalog 12-D2 tells the full story.



Recommended practice: Open valve nearer boiler first. Then slowly open other valve. After blow-off, close second valve first; then valve nearer boiler. This places greatest wear on blowing valve, assures a tight valve next to boiler, facilitates repair without a boiler shut-down.

Popular for high pressure installations, the Edward welded-bonnet Univalve* meets Code requirements for blow-off service and is ideal all-purpose globe valve as well. Edward blow-off valves are available in all pressure classes from 300 lb to 2500 lb in angle or straight-way styles, with flanged or welding ends.



Premium Features of Edward Blow-off Valves

- INTEGRAL SEAT of chromium-cobalt-tungsten alloy. Applied directly to body in a continuous ring, then machined in same set-up with bonnet guide bore for perfect alignment. Highly resistant to abrasion and corrosion.
- HARD-FACED DISK—Stellited for maximum resistance to abrasion and corrosion. Edward swivel-disk construction allows stem to lift vertically away from seat. No grinding or galling.
- POSITIVE BACKSEAT isolates packing from the high temperature zone. Line-contact backseat seals EValpak* valve packing from line pressure, permits repacking under pressure.
- IMPACTOR HANDLE, an Edward exclusive, is standard equipment. Several times more effective than ordinary handles or handwheels in opening or closing valves.

EDWARD VALVES, INC.

1202 West 145th Street, East Chicago, Indiana

Subsidiary of

ROCKWELL MANUFACTURING COMPANY

Represented in Canada by

LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St. W., Montreal 1, Que.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

*T. M. Reg. U. S. Pat Off.

For more data circle 508 on Post Card

In the last two years...

All These Improvements

Whether your fly ash problems require a straight precipitator, a combination unit, or a mechanical collector alone, you can count on an economical solution from Research-Cottrell.

1. New Cyclo-trell—Sets new standards for collection efficiency and gas volume capacity. Double deck arrangement improves gas distribution to precipitator and conserves valuable space. Collecting tube is erosion resistant.

Cottrell Automation System—Higher "around-the-clock" collection efficiency, without manual adjustments. New electronic methods provide continuous optimum energization.

2. Opzel Collecting Electrodes—New design cuts cost, provides optimum precipitation zone with better gas flow and electrical conditions.

3. New Discharge Electrode Rappers—Available in air, electric, vibrating or impact type. Cycle and intensity are easily adjusted to maintain highest collection efficiency.

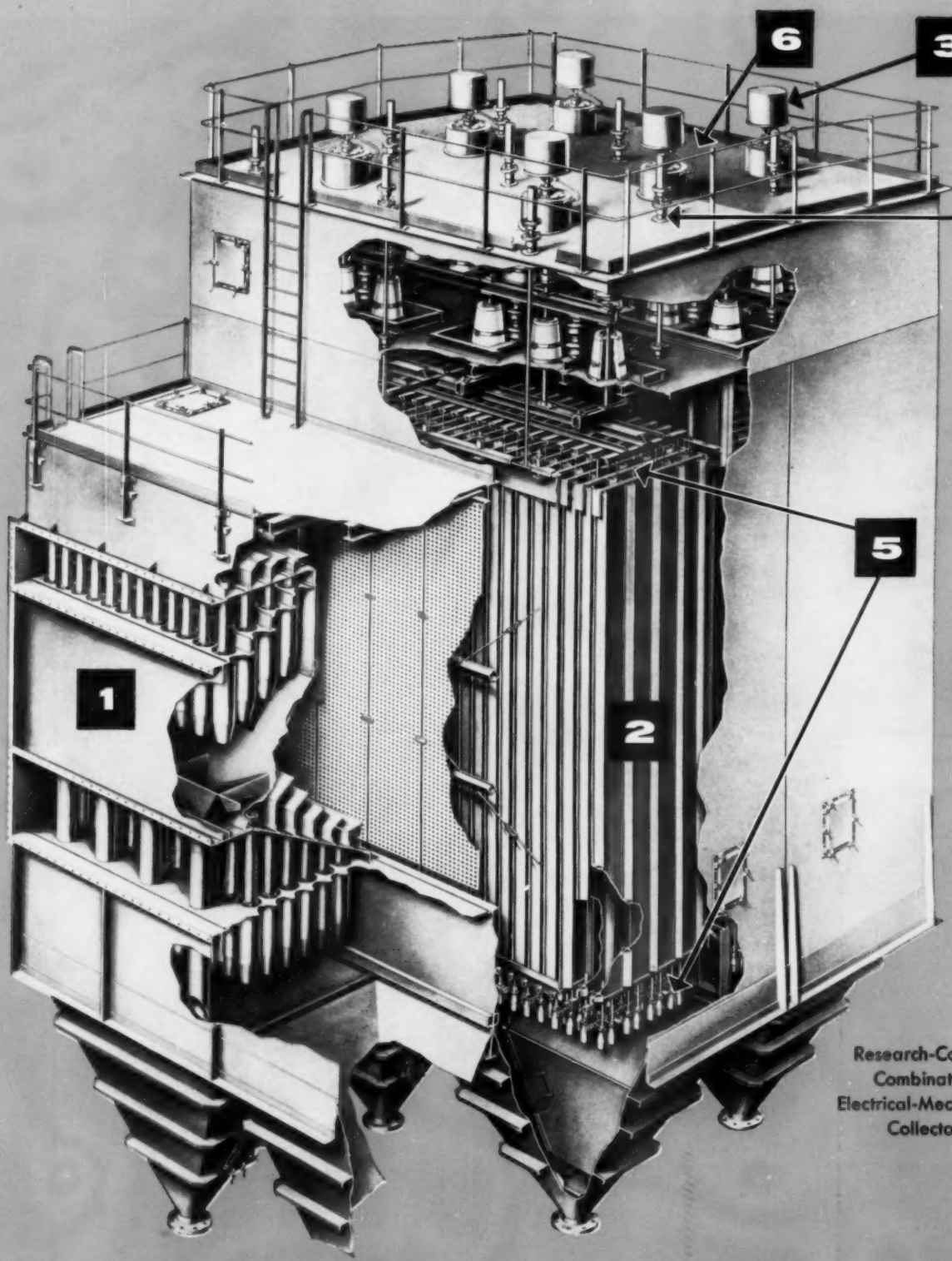
Silicon Rectifiers—New, hermetically sealed rectifiers last as long as the precipitator—without maintenance. Rectification efficiency is 96% to 99% with no voltage drop due to age.

4. M. I. Rappers on Roof—New arrangement provides better rapping and easier access to automatically controlled rappers, without additional expensive platforms.

5. New Discharge Electrodes—No. 430 stainless steel discharge electrodes are individually hung for easier access from top to bottom. Entire collecting plate surface is effective because the discharge wires extend well beyond the top and bottom of the plate.

6. New Top Constructions—Insulator compartments or steel housing over the entire roof are available. Designed for low insulator maintenance; bushings can be replaced without disturbing high tension frame. Top housing provides "out-of-weather" working space for maintenance.

RC-179



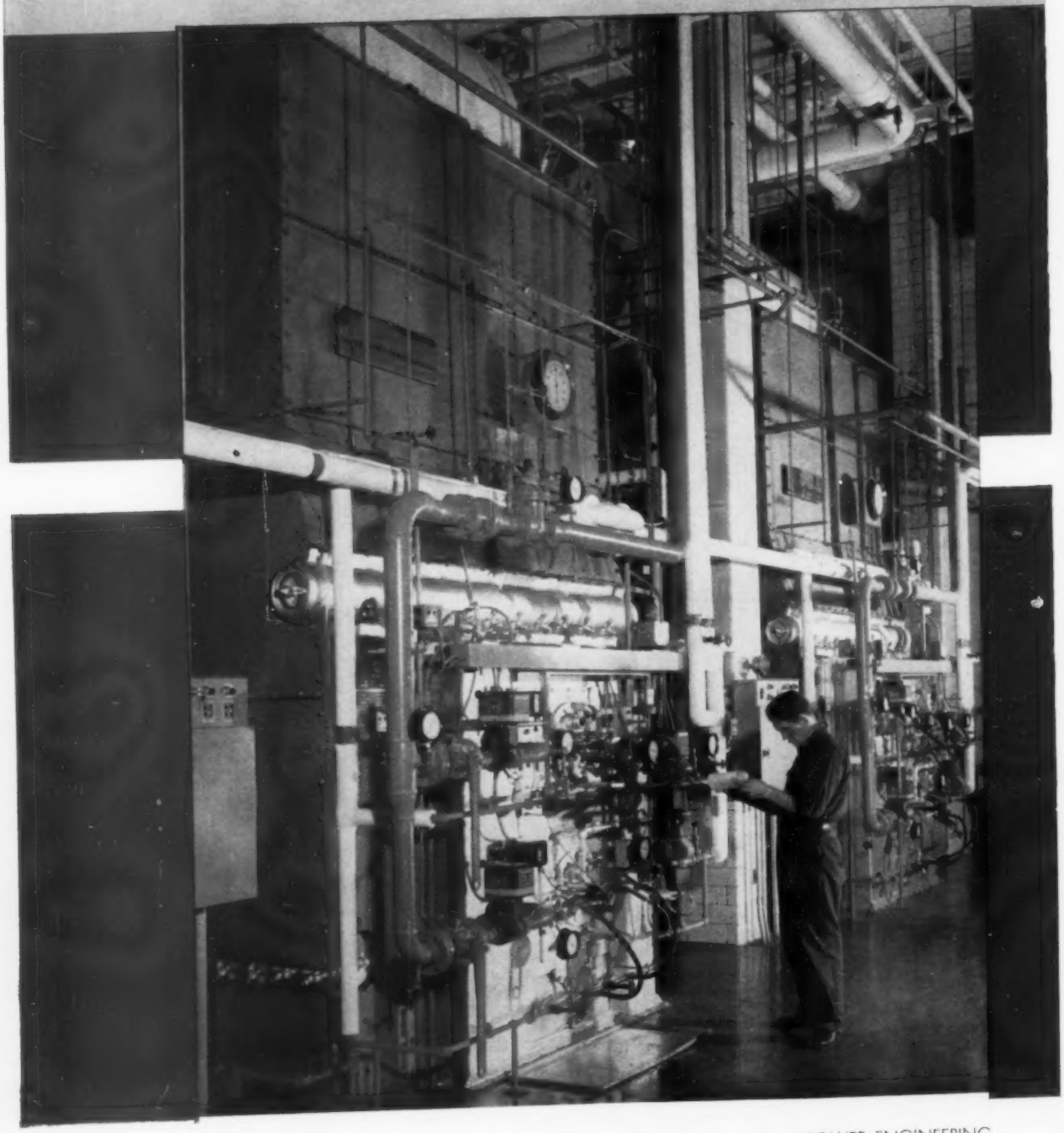
Research-Cottrell
Combination
Electrical-Mechanical
Collector

Research-Cottrell

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 58 Sutter Street, San Francisco 4, Calif. • Research-Cottrell (Canada) Ltd., 33 Bloor Street East, Toronto 5, Ontario.

WICKES TYPE S-1AL

HEAT ONE OF AMERICA'S



STEAM GENERATORS
MOST MODERN BUILDINGS

CONNECTICUT GENERAL LIFE INSURANCE CO., Bloomfield, Conn.

ARCHITECTS:
Skidmore, Owings & Merrill

GENERAL CONTRACTOR:
Turner Construction Co.

MECHANICAL CONTRACTOR:
Kerby Saunders, Inc.

A recent exhibit at the National Gallery features 10 of America's most modern buildings. The American Institute of Architects, on the occasion of its Centennial, included in the exhibit the new home office of the Connecticut General Life Insurance Company in suburban Hartford, which is equipped with Wickes boilers. This spacious, sun-flooded building of steel and glass, is nearly a modern city in itself, for it houses not only the complete office system, but includes employee lounges, game rooms, medical department, mailrooms, auditorium, bowling alleys, barber and beauty shops as well.

For the heating system in this mammoth structure, engineers chose to install two Wickes type S-1AL steam generators equipped with both oil and gas burners. In addition to general heating, the steam generators provide power to operate the refrigeration machines and a snow-melting system on the truck ramp. The boilers each have 3700 sq. ft. of heating surface, and were designed for a maximum continuous load of 27,500 pounds of steam per hour at 200 PSIG.

Bulletin No. 55-1 gives complete facts on Wickes products. New engineering bulletins on Type-S and Type-A Steam Generators are also available on request.

WICKES

WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* Boston • Chicago • Cleveland • Dallas • Denver • Detroit • Houston Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • New Orleans • Portland, Ore. • Saginaw San Francisco • Springfield, Ill. • Tulsa

For more data circle 510 on Post Card

In All

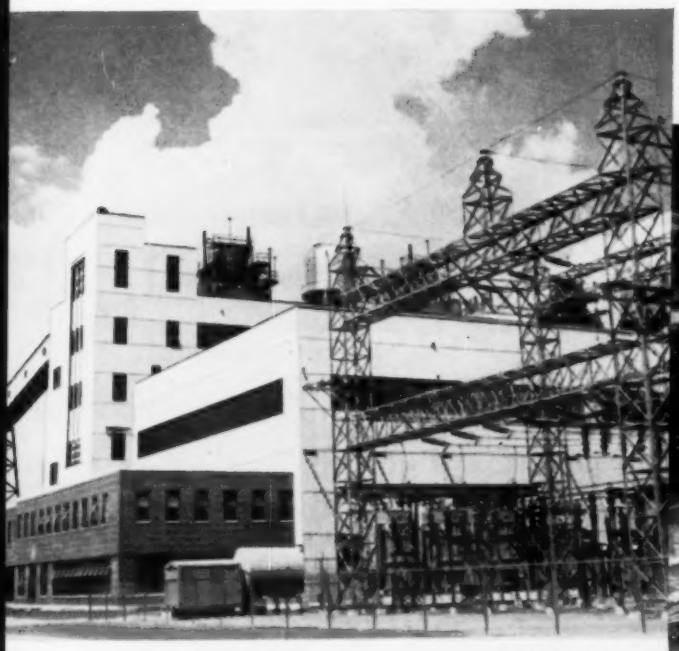
Hammond Plant near Rome, Georgia. Three 100,000 KW steam-electric units are in operation.

14" Alloy Steel Gate Valve
Pressure Seal Type
Geared Head Operation.

16 Steam Generating Units

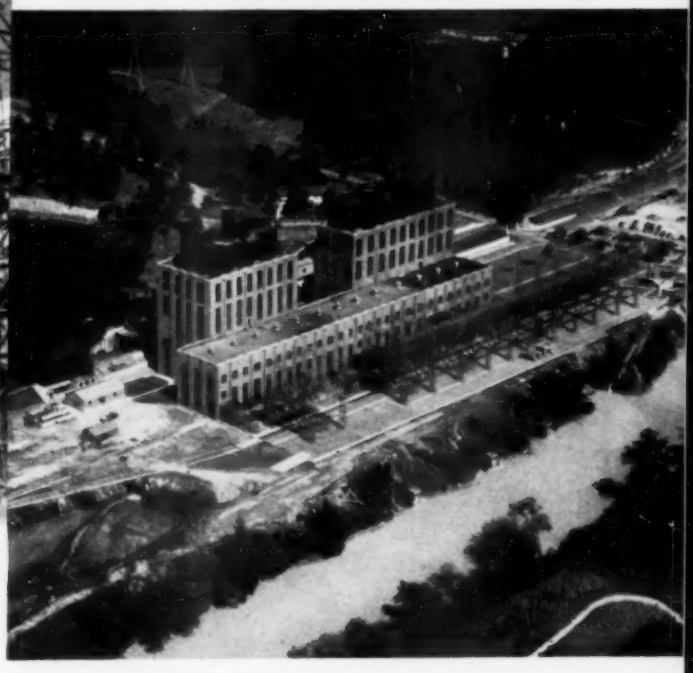
CHAPMAN VALVES

do their part to serve the Citizens of Georgia



Yates Plant near Newman, Georgia. Three 100,000 KW and two 125,000 KW steam-electric units in operation.

Plant Atkinson at Atlanta. Four 60,000 KW units in operation.



You'll find 16 generating stations of the Georgia Power Company located throughout that great state. More units are constantly being added. Total capacity of this huge system, existing and under construction, is 1,843,680 kw . . . an extensive service to the citizens of Georgia.

In every one of the 16 generating plants, engineered by Southern Services, Birmingham, Alabama, you'll find Chapman High Pressure Valves playing their part.

These valves have been selected for many of the major services in each of these plants because they give excellent continuous service under severe operating conditions. They meet the growing demands of increased temperatures and pressures which are requirements for modern power plant operations.

The CHAPMAN *Valve Manufacturing Company*

INDIAN ORCHARD, MASSACHUSETTS

Looking ahead. When it comes to valves, if you are looking ahead to tomorrow's requirements talk with the Company that is looking ahead . . . Chapman Valve Manufacturing Company. Chapman will plan with you, work with you, *produce for you.* Chapman has the engineers, metallurgists, experience and manufacturing facilities to design, develop, build and test the valve equipment you need no matter how tough the requirements. Write and we'll gladly consult with you.

For more data circle 511 on Post Card

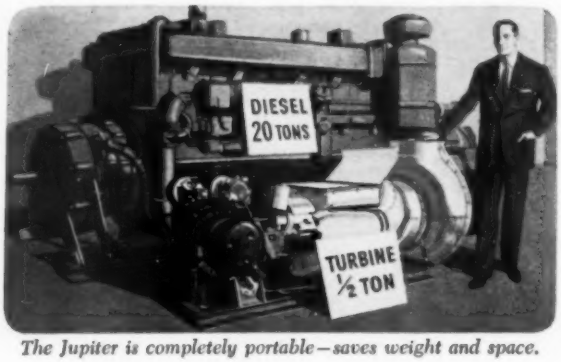
Four amazing advantages of Solar Gas Turbine Engines

Gasoline—any kind.

Diesel oil

Kerosene.

Natural gas.



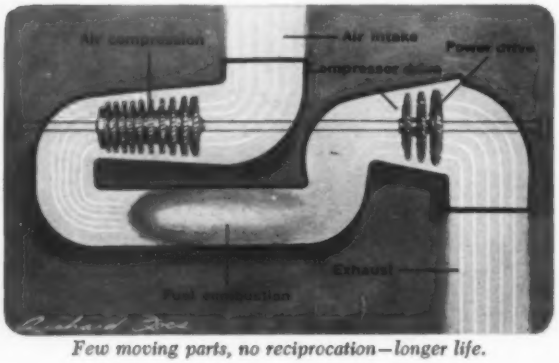
The Jupiter is completely portable—saves weight and space.

❶ Uses whatever fuel you've got!

Solar gas turbines can operate on almost any available fuel—fuel that costs the least for *your* particular operation. Located in remote areas, for instance, self-sufficient Solar turbines can take fuel directly from a gas pipeline! This often results in lower total operating costs.

❷ Light—500 hp in 1/5 the space!

Solar's 500 hp Jupiter® engine is only one-fifth the size of a diesel of similar horsepower—and weighs *forty times less!* The entire unit is easily transported to remote locations. And it is especially suited to applications where space limitations create a troublesome installation problem.



Few moving parts, no reciprocation—longer life.

Instant acceleration—takes full load without laboring.

Instant emergency power.

Starts in any climate.

❸ Simple design—low maintenance!

Gas turbines are the simplest of all heat engines. In operation, large volumes of air are drawn in by the compressor, mixed with fuel in the combustion chamber, greatly expanded, and delivered to a turbine which produces shaft power. Routine servicing can be completed in a few hours at most. Overhauls are infrequent. Simple design and low maintenance make gas turbines ideal for a wide range of important applications—including boat propulsion, portable power generation, air compression and chemical processing. And other applications for these versatile power plants of the future are limited only by the imagination.

❹ Starts instantly—no warm-up!

Solar gas turbines can be turned on or shut down in seconds. And they require no warm-up—even after long periods of stand-by service. No matter what your business, no matter what your power needs, these amazing advantages can benefit you. Write to Dept. F-14, for free gas turbine brochure.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

2200 PACIFIC HIGHWAY • SAN DIEGO 12, CALIFORNIA

For more data circle 512 on Post Card

Premium quality extruded steel pressure tubing at standard prices

Transverse Strength, 30% to 50% higher than conventional, withstands higher internal pressures.

Improved Internal Finish offers less resistance to flow — reduces pressure drop.

Fewer and Faster Field Welds, due to close concentricity and uniform wall thickness. 50-foot lengths require fewer joints, reduce welding costs 50-60%.

High performance Chrome-Moly Alloy extruded steel pressure tubing *...in diameters from 14" to 18" o.d....in standard wall thicknesses ...in lengths from 20 to 46 feet...* is now available *from stock* for immediate delivery at standard prices.

Other diameters, of Chrome-Moly and Austenitic Stainless, ranging from 10" to 20" with wall thicknesses ½" to 5¼" and in lengths up to 50 feet, are available on a four-month delivery schedule.

The unusual properties of this extruded tubing, such as exceptionally high transverse strength, impact strength and ductility, make it ideally suited to high-temperature, high pressure applications in the power, petrochemical, food processing and other process industries.

Contact our nearest distributor or district office. Experienced application engineers are available for consultation.

Complete Engineering and Processing Services for: ***Extrusions • Castings Forgings • Machining***

METALS PROCESSING DIVISION

CURTISS-WRIGHT

CORPORATION • 91 GRIDER ST. BUFFALO, N.Y.

Distributors: Capitol Pipe & Steel Products, Philadelphia, Penna. • Tube Sales, Los Angeles, California • ***District Offices:*** Chicago, Illinois, 208 South LaSalle Street • Wood-Ridge, New Jersey, Main and Passaic Streets • North Hollywood, California, Van Owen & Vineland • Dayton, Ohio, 131 North Ludlow Street • Export Division, 50 Rockefeller Plaza, New York, N. Y. • Montreal, Quebec, Canada, 1980 Sherbrooke Street, West.

For more data circle 513 on Post Card

ONE-SHOT "BOILER TREATMENT" GETS UNEXPECTED RESULTS

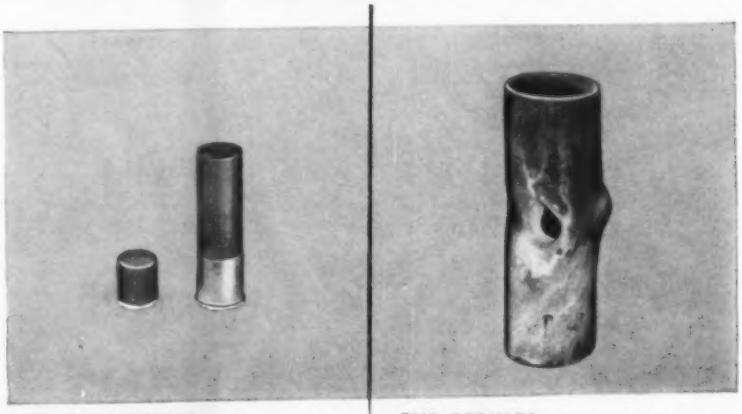
CEMENT MANUFACTURER SHOOTS THE WORKS!

CLEANING rotary cement-drying kilns by firing lead slugs into them to knock off accumulations inside is routine practice. The slugs go bounding and bouncing through the long drying kiln, doing a cleaning job equivalent to a whole crew of pick-and-shovel pilots. No one expects a slug to become so enthusiastic that it continues its chores inside the waste heat boiler attached to the far end of the kiln. In fact, the odds against getting a slug into the boiler *on purpose* are astronomical. But this one got there, odds and all, thus establishing a new type of one-shot boiler treatment which is hardly likely to become popular.

HOWEVER, *inside* the boilers at this large cement plant, Nalco System treatment helps make certain that boiler troubles, if any, are on the outside. Boiler feedwater is aerated, filtered, zeolite softened, evaporated and deaerated. A Nalco corrosion inhibitor is fed between deaerators and feed pumps for corrosion control throughout the steam and condensate return systems. Nalco catalyzed sodium sulfite does the oxygen scavenging on the discharge side of feed pumps. A Nalco internal treatment and caustic soda are fed directly into the boiler for pH control and scale prevention.

It is no wonder these boilers can turn out 169,000 lbs. of steam per hour, year after year, and stay like new—except, of course, for the wayward shotgun slug.

Nalco has not yet developed bullet proofing for boilers . . . But you can never tell what may come next! Meanwhile, we'll be happy to tell you more about effective Nalco Internal Treatment. Ask for Bulletin B1. National Aluminate Corporation, 6224 West 66th Place, Chicago 38, Illinois. In the Northwestern United States, Hawaii and Alaska: The Flox Company, Inc., Minneapolis, Minnesota. In Canada: Alchem Limited, Burlington, Ontario. Branches and affiliates in Spain, Germany and Italy.



THE TREATMENT: Lead slug, propelled by heavy powder charge in 8-gauge shell fired from a miniature cannon! "External treatment" with a vengeance.

THE RESULTS: "Plugged" boiler tube, pierced by lead slug on the pay off to one chance in a million. Internal treatment powerless here.

Steam drum in one of the Nalco-treated boilers at cement plant is typically clean and corrosion-free when opened for annual inspection.

Water treatment chemical mixing and proportioning room, where Nalco System treatment starts on its way to give complete steam system protection against scale and corrosion.

For more data circle 514 on Post Card

HELPFUL BULLETINS

INSTRUMENTS AND CONTROLS

101 Automatic Controls — Catalog 858, 60 pp, features a line of automatic controls for pressure, temperature, liquid level and mechanical movement. Profusely illustrated with photos, drawings and diagrams, the catalog also presents data on relays and both magnetic and tilting type mercury switches. Tabulated engineering data are included, as well as detailed ordering and application information. The Mercoid Corp.

102 For Supervisory Control — Twenty-pp Bulletin GET-2738 gives detailed information on description, operation and application of code selector supervisory control equipment. Covers equipment for master and remote stations; applications for control of a-c switching stations, hydro generating stations, pumping stations, others. Includes charts, pictures, system features, elementary system diagrams, simplified instructions, ratings, dimensions. General Electric Co.

103 Eyes of Automation — This 24-pp booklet contains illustrations, descriptions, application diagrams and data on photoelectric controls. Covers normal, high speed, ultra sensitive and impulse actuated photoelectric controls, plug-in mounted units, photoelectric timing controls, dual function units operated by the same phototube, others. Autotron, Inc.

104 Metering, Control Systems — Bulletin 500 describes pneumatic and electric telemetering, pneumatic control. Includes references to detailed literature on all products making up these systems. Bailey Meter Co.

105 Flow Tubes — Twenty-pp Technical Bulletin 115-L3C gives comprehensive technical data on the design, metering characteristics, flow formulae, the capacity and accuracy, installation information, accessory items, and similar engineering information on the Dall Flow Tube. It is illustrated with photos, sketches, charts, of interest to power engineers concerned with technical aspects of this low head-less differential producer. Builders-Providence, Inc., Div. of B-I-F Industries, Inc.

106 Flow Meters — Features and applications of company's Series 500 flow meters for recording, integrating, indicating and automatic controlling are explained in 40-pp Bulletin F1605. Includes information on mechanical and electric flow meters, flow meter charts, meter bodies, primary devices for flow measurement, electric flow meter transmitters and receiving instruments, receivers for remote measurement of flow, pneumatic transmission instruments. Describes applications and includes dimensions. The Bristol Co.

107 Venturi Tubes — Comprehensive information on the various types of Venturi tubes, their recovery characteristics, the formulae that determine their design, typical calculations, and similar data is presented in 32-pp Technical Bulletin 110-P1. Includes a discussion of Venturi design, installation instructions, economics of Venturi metering, various accessories available, and complete specifications. Includes diagrammatic sketches, comparison charts and graphs, installation drawings, and capacity tables. Builders-Providence, Inc., Div., B-I-F Industries, Inc.

108 For Temperature Measurement — Catalog 175, 8 pp, includes descriptive and technical data on company's optical, micro-optical, radiation, immersion, surface and indicating pyrometers. Features and principles of operation are detailed and specifications included. The Pyrometer Instrument Co., Inc.

109 Pyrometer Supplies — Catalog G-100-8, 54 pp, describes thermocouple assemblies and components for measuring temperature. Design and construction features are covered and general information on thermocouple theory and practice given. Catalog contains thermocouple selection data, tables giving suggested protecting tube or well materials for common applications, thermocouple accuracies, chemical and electrical data, dimensional and specifications data. A section covers thermocouple components. Minneapolis-Honeywell Regulator Co.

110 Photo-Manometers — Eight-pp Catalog 2900 describes multiple-tube well-type manometers with translucent scales and built-in backlighting, designed to be photographed to obtain simultaneous readings and permanent records of measurements. Lists features available to meet individual requirements, shows five photo-manometers and gives specifications. King Engineering Corp.

111 Feed Water Regulator — Bulletin M85–1 describes thermo-hydraulic type regulator for control of feed water to small boilers, Construction, operation, and dimensions are provided along with other information. Bailey Meter Co.

112 Speed Indication — Twelve-pp Booklet 58 covers advantages and applications of speed indication and describes company's line of tachometers. Includes a series of line drawings with dimensions showing various ways in which these tachometers may be installed in different applications. Jones Motrola Corp.

MECHANICAL POWER TRANSMISSION

113 Any-Speed Drives — Advantages of company's fluid power any-speed drives are illustrated and described in 32-pp Bulletin 10600. Contains numerous performance curves representing operating characteristics of the drives, as well as pictorial diagrams of component features. Typical jobs that can be handled are also detailed. The Oilgear Co.

114 Improved Belt Drives — Application range of company's Timing belt drives for power transmission, synchronization and for functional applications is described in 68-pp Catalog TB-58. Contains information on all five basic belt pitches, as well as complete engineering data, selection, installation and uses of these drives. Morse Chain Co.

115 Transmission Belting — This 20-pp catalog describes the Swedish Trelleborg V-belts and endless flat cord belts. Generously illustrated, gives information on design and construction of the belts and tells how to select, install and maintain them. Dimensional data is provided, and some installations of the belting are pictured. Homestrand, Inc.

116 Roller Chains, Attachments — Eight-pp Bulletin 507 includes complete pricing information on standard attachments for standard and double pitch roller chains. These attachments and some suggestions as to how they can be used are illustrated. Diamond Chain Co., Inc.

VALVES, TRAPS, PIPING AND FITTINGS

117 Swing Check Valves — Bulletin 8K describes company's line of swing check valves designed for service in steam or water lines to protect against reverse flow. Included is detailed information on basic swing check valve and modifications. Sectional drawings show construction of each type of valve. Schutte and Koerting Co.

118 Globe Valves — Bulletin B-2, 20 pp, illustrates and describes company's line of globe valves for a variety of industrial services. Complete descriptive details are included, as well as dimensional data and cutaway views showing design and construction features. Engineering data given. Associated Valve & Engineering Co.

119 Bronze Valves — Described and illustrated in this bulletin are 150-lb WSP bronze globe, angle and check valves. Bulletin contains service ratings, dimensional drawings for each type of valve and an exploded view of a globe valve with matching text for each component. Inventory and service advantages of interchangeability of parts are detailed. Walworth Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 105 and 106.

120 Coke Quenching Valves — Technical Bulletin W-15 describes installation arrangements, parts lists, and dimensions of coke quenching and drain valves. Golden-Anderson Valve Specialty Co.

121 Impulse Steam Traps — Eight-pp Bulletin T-1742 (57) gives detailed information on company's line of impulse steam traps designed to serve a variety of trapping requirements. Typical installations are shown and dimension, capacity, weight and price lists included. Yarnall-Waring Co.

122 Trap Maintenance Tips — This handy reference card contains information which can be used to quickly spot defective steam traps. Included are steam trap data showing the steam temperature one can expect below a normally functioning trap for a steam supply pressure. Tempil Corp.

123 On Stainless Fittings — Eight-pp Catalog 10.0 presents uses and advantages of Quikupl stainless steel fittings. These are designed to permit use of economical light wall tubing, although also available for both OD tube and IPS sizes. Booklet cites examples showing how installation costs were reduced by using Quikupl fittings. A table shows relative effects of more than 330 chemical materials on the Neoprene, Butyl and Thiokol-Quikupl seal rings. Simplified sectional drawings of the fittings are included. Vanton Pump and Equipment Corp.

124 Grooved-End Tubing — This 8-pp illustrated brochure describes mill grooved Electrunite lightweight steel tubing for use as portable pipe line with standard mechanical couplings. Stresses advantages of the portability offered by a piping system that can be set up and broken down quickly. Republic Steel Corp.

INSULATION

125 Hot Pipe Insulation — Featured in this bulletin is a speed-fastening, mineral wool material, with tie wires attached, for easy application on pipes with temperatures to 1200 F, and from 4 to 30 in. diam. Thermal and physical characteristics of both this new insulation and a conventional pipe insulation are presented. Baldwin-Hill Co.

126 Thermal Insulation — Insulation solutions for a variety of temperature problems are detailed in this bulletin. Describes insulations for high temperatures, intermediate temperatures, hot and cold water-low pressure steam, ice water and frigid temperatures, and miscellaneous applications. An insert discusses advantages of company's expanded polystyrene board and pipe covering. Mundet Cork Corp.

PUMPS, COMPRESSORS

128 Centrifugal Pump — Bulletin 1440, 8 pp, describes company's Type A5 centrifugal pump of the volute type for horizontal or vertical installation. Diagram shows use of pump in hot or chilled water air conditioning systems and as a circulator in a cooling tower. Bulletin includes dimensional data, rapid selection chart, fitting data for pipe size, and table of altitude and water temperature correction. Dunham-Bush, Inc.

129 Liquid Ring Pump — Bulletin 725.6 describes light weight, self-priming, portable or permanent liquid ring pump for transfer and similar jobs, which handles air alone, liquid alone or any combination of air and liquid. Specifications, performance and construction data are included. Goulds Pumps, Inc.

130 Mixed Flow Pumps — Low- and high-head mixed flow volute pumps for sewage disposal, drainage, flood control, irrigation, raw water pumping, or for any relatively clear liquids are described in 6-pp Catalog F-102. Design and construction details for horizontal and vertical mixed flow volute pumps are presented. C. H. Wheeler Mfg. Co.

131 High Pressure Pump — Technical Bulletin 252 features high pressure screw pumps for various oil services at discharge pressures to 1000 psig and viscosities from 35 to 75,000 SSU. Selection nomographs, outline dimensions, sectional view and details of design and construction are provided. Warren Pumps, Inc.

132 Pump Selector — Bulletin 158 briefly describes company's many types of pumps, all designed for abusive applications, such as those involving corrosion, abrasion, high temperature or a combination of them. Photos are included along with descriptions of design and operating features, uses. Nagle Pumps, Inc.

133 Pump Design Considerations — What causes radial loads, how to measure them and how their effects on manufacturer's process pumps are controlled, are discussed in Engineering Bulletin EM-79, "Mechanical Considerations in Pump Design." Describes cause, effect and cure of damaging radial thrust forces on impellers, bearings, wear rings, seals and stuffing boxes and the shaft. Formulas and diagrammatic explanation of the findings are presented. Peerless Pump Div., Food Machinery and Chemical Corp.

134 Centrifugal Compressors — Bulletin 150, 62 pp, describes features and applications of company's line of multi-stage horizontally-split and vertically split centrifugal compressors. In addition to complete mechanical data, it contains engineering data and performance characteristics, curves, and guide to writing specifications. It is profusely illustrated with photos, drawings. Clark Bros. Co.

HEATING, VENTILATING AND AIR CONDITIONING

135 Heating, Ventilating Units — Bulletin 8927, 48 pp, describes company's redesigned line of heating and ventilating units. Separate sections are devoted to coils, fan section and accessories. Details of construction are discussed, and tables giving steam heating capacities, hot water heating capacities and fan capacities included, as well as air friction tables, filler data, recommended selection procedure, physical data, and diagrams. American Blower Div., American-Standard.

136 Ventilating Fans — Bulletin UVS-104, 28 pp, describes belt-driven ventilating units with either forward curve wheels or backward blade non-overloading wheels. Also includes complete performance tables, engineering data, selection and installation information and full specifications on 12 basic size package fans. General Blower Co.

137 For Heating, Ventilating — Twelve-pp Bulletin 701, on Herman Nelson products, features Roll-O-Vent automatic filter section and its adaptation to heating and ventilating units, industrial unit heaters and air conditioning units. Also covers convector radiators, finned radiators, unit heaters, console heaters, propeller fans, unit blowers, industrial exhausters and centrifugal fans. Tables and charts outline performances, capacities, dimensions, range, ratings, other data. American Air Filter Co., Inc.

ELECTRICAL

138 Shaded Pole Motors — Bulletin GEA-6134B is a 12-pp publication containing design, dimension, rating, performance, and application data on shaded pole motors for such applications as window, ventilator and condenser fans, unit heaters, small direct-drive furnace heaters, dehumidifiers, and evaporative coolers. Cutaway views show component features and tables give ratings, dimensions and other data, General Electric Co.

139 Integral Distribution Center — Bulletin GEA-6619, 16 pp, contains complete data on company's dry-type integral distribution center for such applications as industrial plants and warehouses, office and commercial buildings, and others. Tells how one-piece construction saves space, simplifies specifying, ordering, and installation. Model numbers, dimensions, and choice of incoming line components are given. General Electric Co.

140 Medium Transformers — Bulletin GEA-6108B, 32 pp, offers detailed descriptions, ratings and characteristics, performance data, weights and dimensions, standard and optional accessories of company's RM (repetitive manufacture) medium transformers. Illustrated with photos, drawings, graphs, charts and tables, bulletin features transformers with RM-ASA ratings of 501–5000 kva, single phase, and 501–10,000 kva, three phase 69 kv and below. General Electric Co.

141 Distribution Transformers — Bulletin 135-A describes company's Type UD transformers which features reductions of 20 per cent in height and weight, as well as other design changes. Data on electrical and mechanical characteristics, standard tap ratings, bushing terminal sizes, quality control practices and core fabrication are included. R. E. Uptegraff Mfg. Co.

142 Stationary Battery — Detailed specifications and installation data for a lightweight Kathanode battery is contained in 12-pp Catalog GB-1833. Includes complete data on all cells from 50 amp-hr to 1140 amp-hr capacity cell. Engineering specifications tabulated include amp hr capacity, discharge rates, overall cell dimensions, weight per cell and electrolyte required. Industrial Div., Gould-National Batteries, Inc.

143 Latch Relays — Mechanically-held latched-in relays which need no extra vertical height are described in Bulletin 7305 — PML. Outlines features of the latch relays, pictures standard models with from 2 to 10 poles, and includes photos and diagrams. The Clark Controller Co.

Do any of these catalogs answer your operating or maintenance needs? Let us know by circling the number of the catalog on the post card provided on pages 105–106. We'll do the rest!

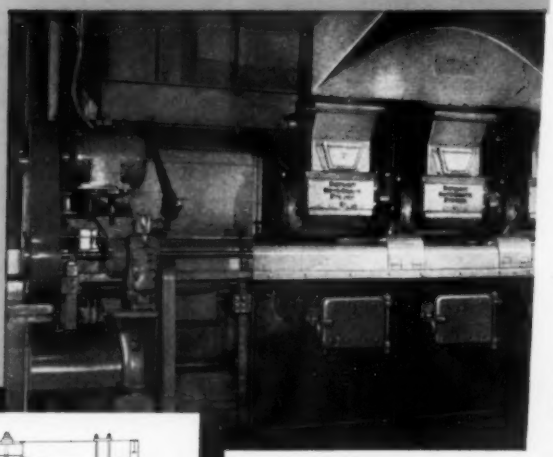
144 Switch, Fuse Equipment — Bulletin GEA-6623 provides data on switch and fuse equipment available in 2.4- to 13.8-kv ratings. Describes product features, typical applications, quality components, safety features and includes charts for equipment application, cross-section drawings, line diagrams, ratings and dimensions. General Electric Co.

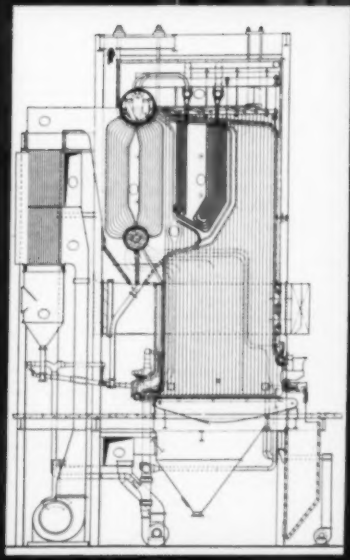
145 Control Equipment — Bulletin GEC-1260C, 88 pp, covers company's line of control devices. Selection charts covering starters through 200 hp provide easy choice of proper starter, heater and push-button station for any enclosure. Catalog provides product descriptions of motor starters, contactors, relays, solenoid, limit switches, pushbuttons and pilot devices. Also contains prices, features, wiring diagrams, dimensions and application information. Indexed for easy reference, in-

Mile High Plant Steam Generator Fired By DETROIT ROTOGRATE STOKER

Southern Colorado Power Co

Note — This information is out dated. Another Roto Grate is being added here, to fire a new 200,000# per hour unit.





This new unit which triples the capacity of the plant consists of a Babcock and Wilcox two-drum single pass steam generator fired by a Detroit Rotograte Stoker having six feeders and distributors. The plant is at 5,300 feet above sea level. Capacity of above unit is 150,000 pounds of steam per hour at 660 psi, 915° steam temperature with preheated air at 350° F.

Design is based on bituminous coal:

B.T.U. per lb as fired	10,828
Moisture	8.84%
Volatile matter	33.72%
Fixed Carbon	44.69%
Ash	12.75%
Sulphur (separately determined)	0.7%

However, operation has been completely successful with coal from various mines in the vicinity.

Detroit RotoGrate is an exceptionally efficient spreader stoker with overlapping highly restricted grates that move slowly forward discharging ash at the front. Permits high burning rates with all Bituminous coals, Lignite or refuse fuels. *Write for Bulletin.*

Southern Colorado Power Co.
Canon City, Colorado
W. C. Porter, Vice President in Charge of Operations
Chester Huskey, Superintendent

Stearns-Roger Manufacturing Co., Denver
Engineers—Constructors
Loeb & Eames, New York, Consultants

DETROIT STOKER COMPANY

MAIN OFFICE AND WORKS • MONROE, MICHIGAN
District Offices or Representatives in Principal Cities

OTHER TYPES AND SIZES OF DETROIT STOKERS FOR EVERY INDUSTRIAL OR POWER NEED

For more data circle 515 on Post Card

The battery 'engineered for control' ... 25-year life ... low maintenance

C & D PlastiCal®

What will be happening when the 1980's roll around? The only thing you can be reasonably sure of is that the C & D *PlastiCal®* Control Batteries you install today ... *will not require replacement until then.*

Twenty-five-year life? Yes! C & D "Control" Batteries are not only designed specifically for control, switchgear, and auxiliary power applications—they're engineered to last a quarter of a century. Users even boast that these advanced lead-calcium plate batteries only have to be watered about *once a year.*

For ample, dependable battery power *instantly* when you need it, it pays to specify C & D *PlastiCal.* It pays ... in the long run, too.

For details, send for Bulletin CP-536

C&D **BATTERIES, INC.**

of Conshohocken, Pa. ... Attica, Ind.

SINCE 1906

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES FROM COAST TO COAST

For more data circle 516 on Post Card

cludes company's "100 Line" manual and magnetic motor starters, illuminated oil-tight and push-to-test pushbuttons, and full acceleration part-winding starters. General Electric Co.

146 Cable Connectors — Twelve-pp Twecolog 11 illustrates and describes company's line of arc welding cable connectors and accessories. Contains photos illustrating important features as well as detailed specifications. Tweco Products, Inc.

147 Cable Support Systems — This 60-pp loose-leaf catalog gives up-to-date information on company's cable support systems, including trough, ladder, channel, and Rak-it system supports and accessories. In addition to the galvanized steel line, this catalog presents aluminum trough, ladder and channel. Includes dimensional detail sheets of value in laying out a trough or ladder system. Generously illustrated and edge-indexed, catalog is available to qualified power engineers, please state your job title when requesting it. T. J. Cope Div., Rome Cable Corp.

148 For Electrical Machinery — Carbon and graphite brushes for all types of rotating electrical machinery is described and illustrated in this 12-pp bulletin. Detailed information is given on selecting the right brush for a specific job, considering such factors as contact drop, coefficient of friction, loads, speeds, filming rates, brush hardness and strength. Brush grade selection is tabulated by machine requirement. A table summarizes brush grades by group, grade designation and key characteristics. Speer Carbon Div., Speer Carbon Co.

BOILERS AND AUXILIARIES

149 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged unit are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

150 Soot Blowing Systems — Bulletin 1029, 16 pp, gives complete engineering descriptions and illustrations of both the selective-sequence and automatic-sequential insert-type panel controllers. Physical dimensions and equipment specifications are included, and a list of typical installations is given. Copes-Vulcan Div., Blaw-Knox Co.

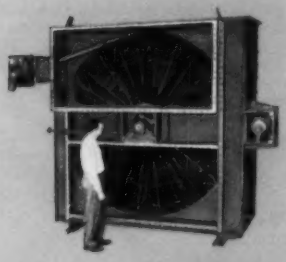
151 Soot Blowers — Long retractable soot blowers are featured in company's recently published Bulletin 1043. Special design features such as dual drives, separate motors (either air or electric) for rotating and traversing the lance, blowing medium valve control, flexibility of mounting are illustrated and described. Copes-Vulcan Div., Blaw-Knox Co.

WATER CONDITIONING

152 Water Consulting Service — Advantages of company's water conditioning and control consulting service are described in 8-pp Bulletin 5006-A. How the consulting service program works is fully illustrated. Dearborn Chemical Co.

153 Demineralization Data — Bulletin WC-111A, 32 pp, is company's revised and enlarged booklet on demineralization (ion exchange). In addition to basic sections on application of demineralizers,

Here's what you can do about the high cost of fuel



Get the same heat from less fuel with a

Ljungstrom® Package Air Preheater

A significant amount of your fuel is used to heat the combustion *air* in your boilers. A Package Ljungstrom Air Preheater raises the temperature of combustion air by recovering the heat from the exhaust gas. In preheated air, the fuel you are now using will burn more completely, and much more of it will be *productive* heat.

Here is an example of what this means in dollar savings. In one year (1956) a typical Package Ljungstrom installation saved $17,600 in fuel costs. In some installations the Package Ljungstrom saved enough fuel to pay for itself in two years.

Compact Package design of the Ljungstrom gives you all the advantages and economies of the Ljungstrom in a preassembled unit. The Package Ljungstrom is available in vertical or horizontal models that are readily adaptable to any plant arrangement.

For further information, write today for the free 14-page Package Ljungstrom manual.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

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FOR PRODUCTIVE MAINTENANCE
DURING PLANT SHUTDOWN
MEGGER LOW RESISTANCE OHMMETER
MIDGET MEGGER CIRCUIT TESTER OHMMETER
MEGGER INSULATION RESISTANCE TESTERS
BIDDLE IMPULSE CABLE FAULT LOCATOR
MEG-TYPE MEGGER INSULATION TESTER
DUCTER LOW RESISTANCE OHMMETER
"TTR" TRANSFORMER TURN RATIO TEST SET

USE BIDDLE INSTRUMENTS FOR ELECTRICAL TESTS

More and more plants are adopting the policy of a complete shutdown for summer vacations. Where possible, it surely pays off, because machines get "tired" too . . . and preventive maintenance can make them well before they get sick. Especially if (in the case of electrical equipment) you use

MEGGER® INSULATION RESISTANCE TESTERS

. . . or any other testing instruments in Biddle's full line of equipment for the practical electrical man. Biddle's File "21" contains a selection of articles and check charts showing how preventive maintenance becomes productive maintenance by saving you thousands of dollars in "unscheduled" downtime costs.

WRITE for FILE 21-PL

MEGGER® GROUND TESTER, TOO . . .

is a vitally important instrument for summertime maintenance. Experience shows that ground resistance *does not remain constant* and tests should be made at least once a year to discover high ground resistance and correct it before lightning strikes. Biddle File "25" gives you a lot of "know-how" to head off costly damage from electrical storms.

WRITE for FILE 25-PE

B-708

JAMES G. BIDDLE CO.

Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

For more data circle 518 on Post Card

their principles of operation and chemistry of the ion exchange resins, bulletin includes information and charts on design and materials of construction. Includes comparison charts on multi-bed, mixed-bed and scavenger or polishing demineralizers. Detailed layouts of each type of system and operating cycle drawings are provided. Other sections cover automatic control, regenerating systems, and chemical handling. Graver Water Conditioning Co.

154 Liquid Mixers — Bulletin 5782 contains design details and other descriptive material on company's line of liquid mixers. Tables listing engineering data are included. General Filter Co.

TOOLS, WELDING

155 Rotary Tools — Detailed information on rotary cutting tools is presented in 48-pp Catalog F-7, covering every type of tool from H.S. steel to carbide, abrasives, and diamond. Book is designed to help in selection of correct tool for particular job. Tools are indexed by type, size and machine application, and is profusely illustrated with photos, drawings and diagrams of features. Precise Products Corp.

156 Gas Welding Equipment — The 36-pp 1958 Welding Equipment Catalog (No. 160) covers recommended applications of company's complete line of oxy-acetylene welding and cutting torches, air-acetylene torches, machine cutting torches, welding regulators, industrial regulators, pressure gages, tank couplings, adapters, hose connections and safety instruction manual. Photos, cutaway views and specifications are included. Modern Engineering Co., Inc.

OTHER EQUIPMENT

157 Hand Hoists — Bulletin DH-164-C describes features and advantages of company's line of safety hand hoists, designed for a variety of materials handling operations. Specifications, clearances, and dimensions are included, as well as photos and dimensional diagrams. Wright Hoist Div., American Chain & Cable Co., Inc.

158 Business Problem Aids — Ways to solve six basic business problems are discussed in 16-pp Bulletin GEA-6459, which cites major benefits offered to electric utilities using factory-built substations. Includes excerpts of reports on factory-built substations. General Electric Co.

159 For Incinerator Service — Bulletin 2350-R-1, 24 pp, provides comprehensive information on the five sizes of two-line, lever arm, clamshell-type buckets; standard two-line, lever arm, tine-type grapples; equalizer arrangements and certain incinerator buckets for single drum hoists. Typical specifications for both clamshell-type buckets and tine-type grapples are included. Blaw-Knox Co.

160 Improved Cooling Tower — This bulletin describes advantages of company's Jet forced draft cooling tower featuring fiber glass construction. Schematic diagrams are included along with dimensions. Koch Engineering Co., Inc.

161 Industrial Machinery — Twelve-pp Bulletin 271 contains a concise description and illustration of each major type of machinery manufactured by this company. Photos of facilities are included, and latest designs of diesel, Duafuel and spark-ignition gas engines are shown and the

POWELL

world's largest family of valves

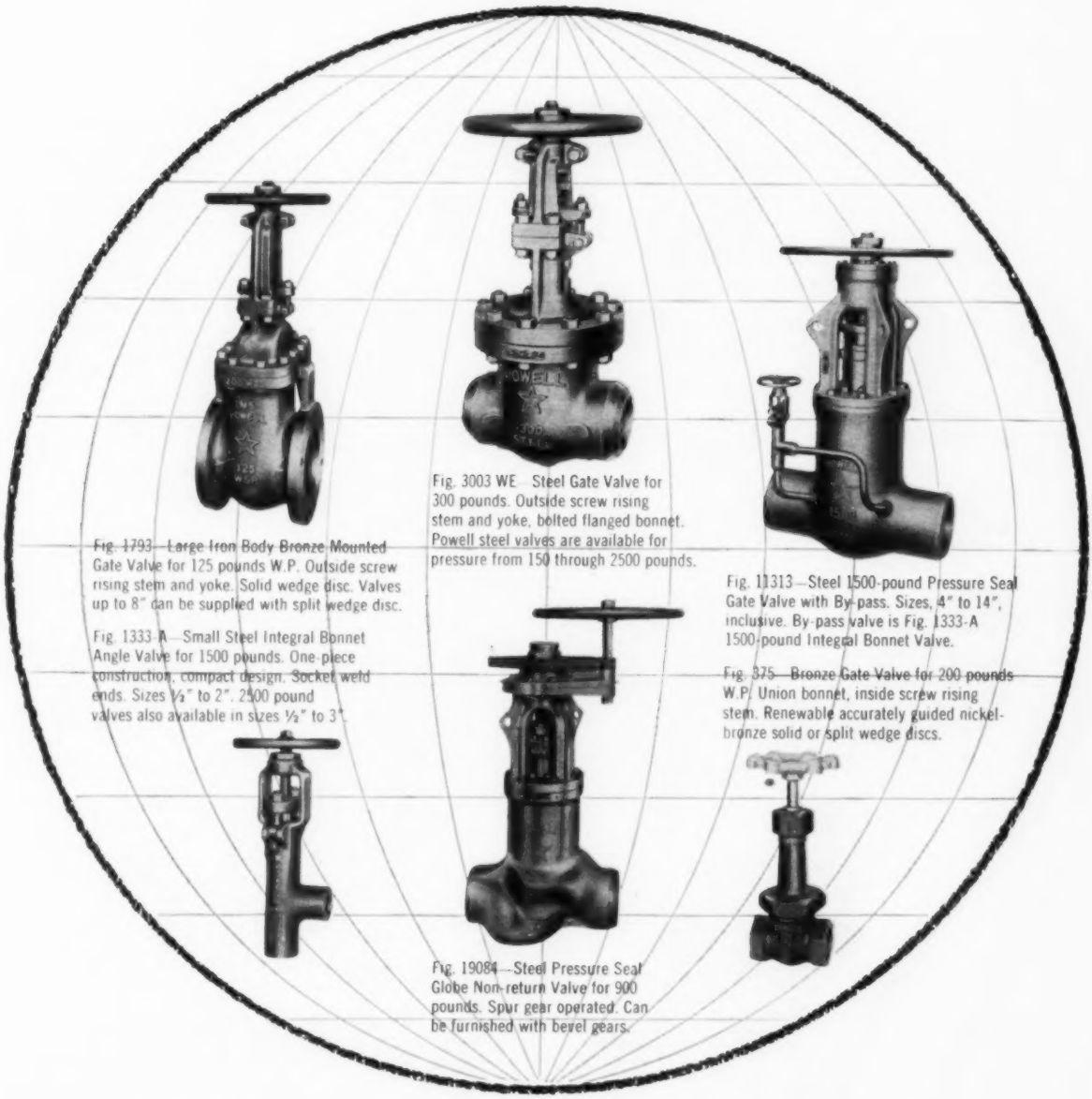

Fig. 1793—Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.P. Outside screw rising stem and yoke. Solid wedge disc. Valves up to 8" can be supplied with split wedge disc.

Fig. 1333-A—Small Steel Integral Bonnet Angle Valve for 1500 pounds. One-piece construction, compact design. Socket weld ends. Sizes ¼" to 2". 2500 pound valves also available in sizes ½" to 3".

Fig. 3003 WE—Steel Gate Valve for 300 pounds. Outside screw rising stem and yoke, bolted flanged bonnet. Powell steel valves are available for pressure from 150 through 2500 pounds.

Fig. 11313—Steel 1500-pound Pressure Seal Gate Valve with By-pass. Sizes, 4" to 14", inclusive. By-pass valve is Fig. 1333-A 1500-pound Integral Bonnet Valve.

Fig. 375—Bronze Gate Valve for 200 pounds W.P. Union bonnet, inside screw rising stem. Renewable accurately guided nickel-bronze solid or split wedge discs.

Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 pounds. Spur gear operated. Can be furnished with bevel gears.

A solution for every kind of flow control problem is as near as your local Powell distributor. Powell valves are designed and engineered in the largest variety of metals and alloys, to handle any medium, every flow control requirement. There are Powell distributors in all principal cities. Or, if yours is a special engineering problem, write to:

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

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ROTOJET®
Tube Cleaners

Clean tubes and pipes from ½" to 12" I.D. THOROUGHLY QUICKLY

ROTOJET Model 512 Air-driven Motor, universal joint, swing-frame head, and solid brush.

Our large stock of Rotojet air-driven and water-driven tube cleaners, accessories, and repair parts for straight and curved tubes, pipes, and transfer lines is available to meet most requirements without delay. Tube cleaner specialization for 43 years assures satisfactory results from any Rotojet equipment we recommend. Send for Bulletins J-410 and R-105. For quick action wire or phone, HUmboldt 3-0570.

ROTOJET Model C-526 Air-driven Motor with pivot head and universal joint.

ROTOJET Model C-525 Air-driven Motor with swing-frame head and universal joint.

ROTOJET Junior Model S32 Air-driven Motor, universal joint, cone cutter.

ROTOJET Junior Model C434 Air-driven Motor, flexible coupling, expanding brush.

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

For more data circle 520 on Post Card

bore, stroke and horsepower range of each is given. Crushers and screens, grinding mills, rotary kilns, other machines are also covered. Nordberg Mfg. Co.

162 Gas Turbine Silencers — How the tremendous noise of a gas turbine engine can be effectively silenced is explained in this 12-pp brochure. Outlines ten steps for determining size and type of unit necessary for a particular installation and includes pictures and drawings of two typical types of gas turbine silencers. Metal Products Div., Koppers Co., Inc.

. . . Outstanding Among This Month's Catalogs

163 Protective Coatings — This 36-pp protective coatings manual, Form 257, is a comprehensive treatise featuring actual color chips of 102 coating items and includes complete sections devoted to methods of surface preparation, use of primers, and finish coatings, and the availability of special custom coatings when required. Covers primers, short oil type coatings, long oil type coatings, restful color group, oil field finishes, heat resistant and chemical resistant coatings. Rust-Oleum Corp.

164 Mercury Floodlighting — Bulletin 640, 18 pp, contains latest information on operating characteristics and operating economics as well as color characteristics of company's Mercury vapor lamps. In addition, there is a section on how to select ballasts with illustrations of the typical ballast types and mountings. Also contains layout diagrams. The Pyle-National Co.

165 Hydraulic Oil Guide — Bulletin B-4 is a 44-pp revision of company's book on hydraulic fundamentals and industrial hydraulic oils. It serves as a practical introduction to principles of hydraulic systems, with illustrated explanations of most important types of valves, pumps, motors, torque converters, and accessories. An explanation of important oil characteristics is followed by sections on oil selection and trouble-shooting. Sun Oil Co.

166 Drafting Templates — Sixteen-pp Catalog 60 carries photos and description of the various types of templates made by the company. An index lists templates by number and by category, including electrical templates, ellipses, mechanical engineering templates, general templates, architectural templates, processing, miscellaneous specialized templates. Rapidesign, Inc.

167 Acid Resistant Ware — Catalog E-956, 16 pp, covers polyethylene and Nylon laboratory products not affected by concentrated acids, oxidizing agents, hydroxides and polar liquids. Illustrates and describes 64 products, among which are beakers, bottles, jars, buckets, tubes, pipets, cylinders, flasks, funnels, tubing, traps, valves, and containers of various types. General Scientific Equipment Co.

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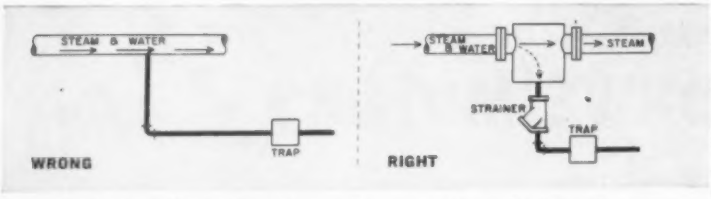
Production-planned systems make best use of traps



As the two illustrations above show, correct application of steam traps is as necessary as using the right trap. In the hook-up on the left, the lack of a condensate collection point plus the long leg to the trap will result in condensate's flowing past the drain point, possibly causing water hammer. The correct way to install the trap is shown at right, placed close to the drain point. A *strainer* should be placed before *any* trap to prevent entrance of scale or other foreign matter into the trap.

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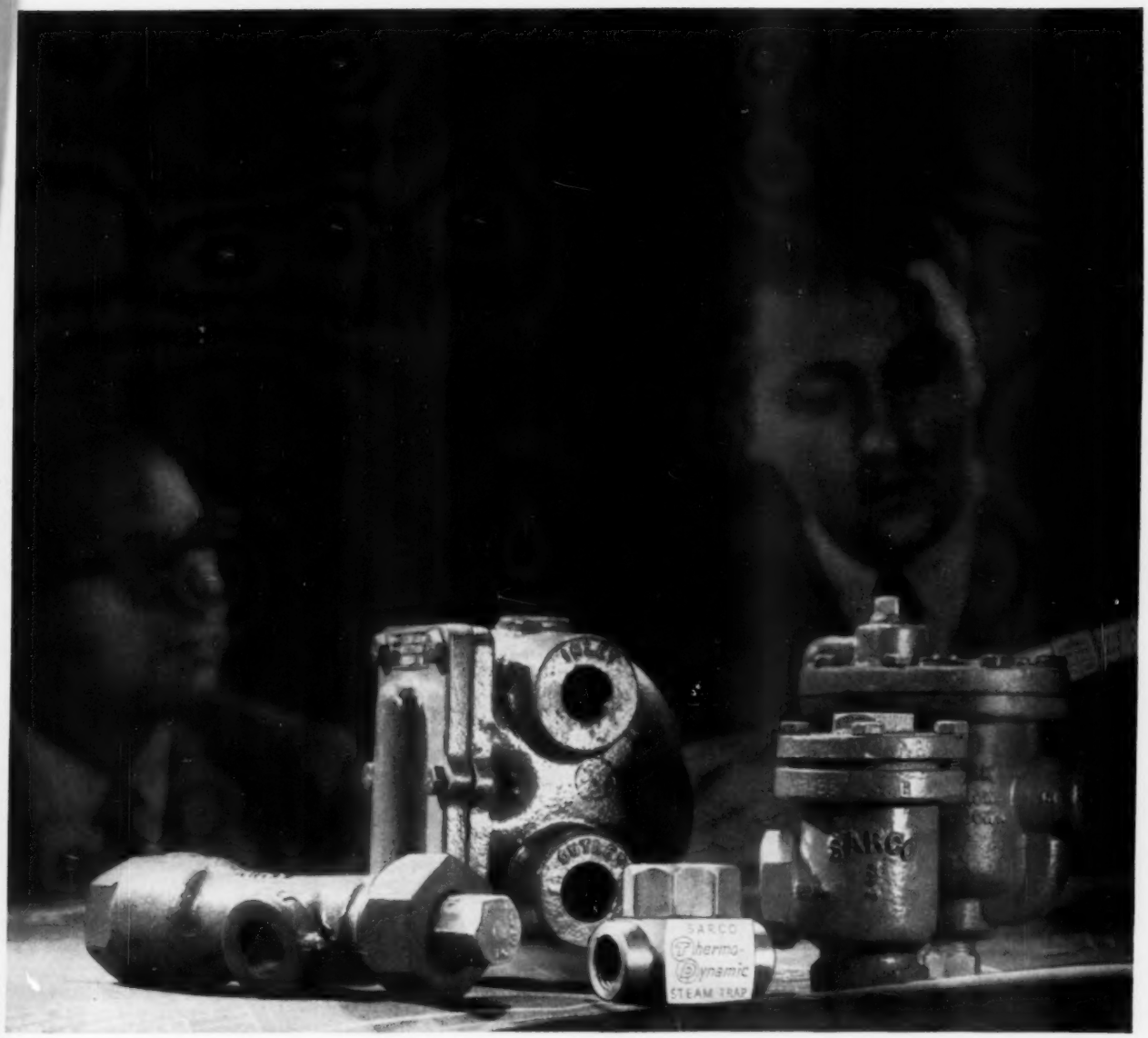
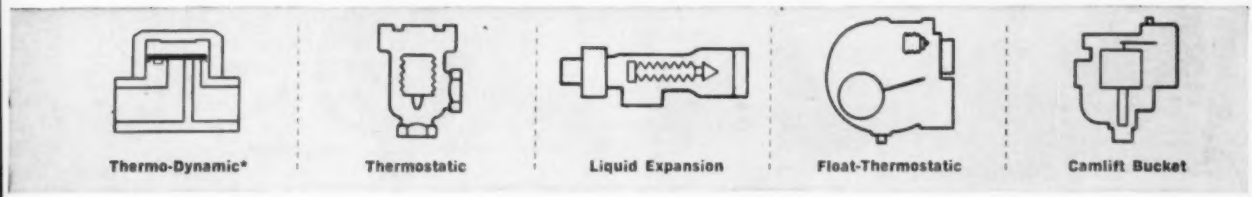


Only Sarco makes these five basic types of steam traps



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Take these two steps to Production-Planned steam trapping:

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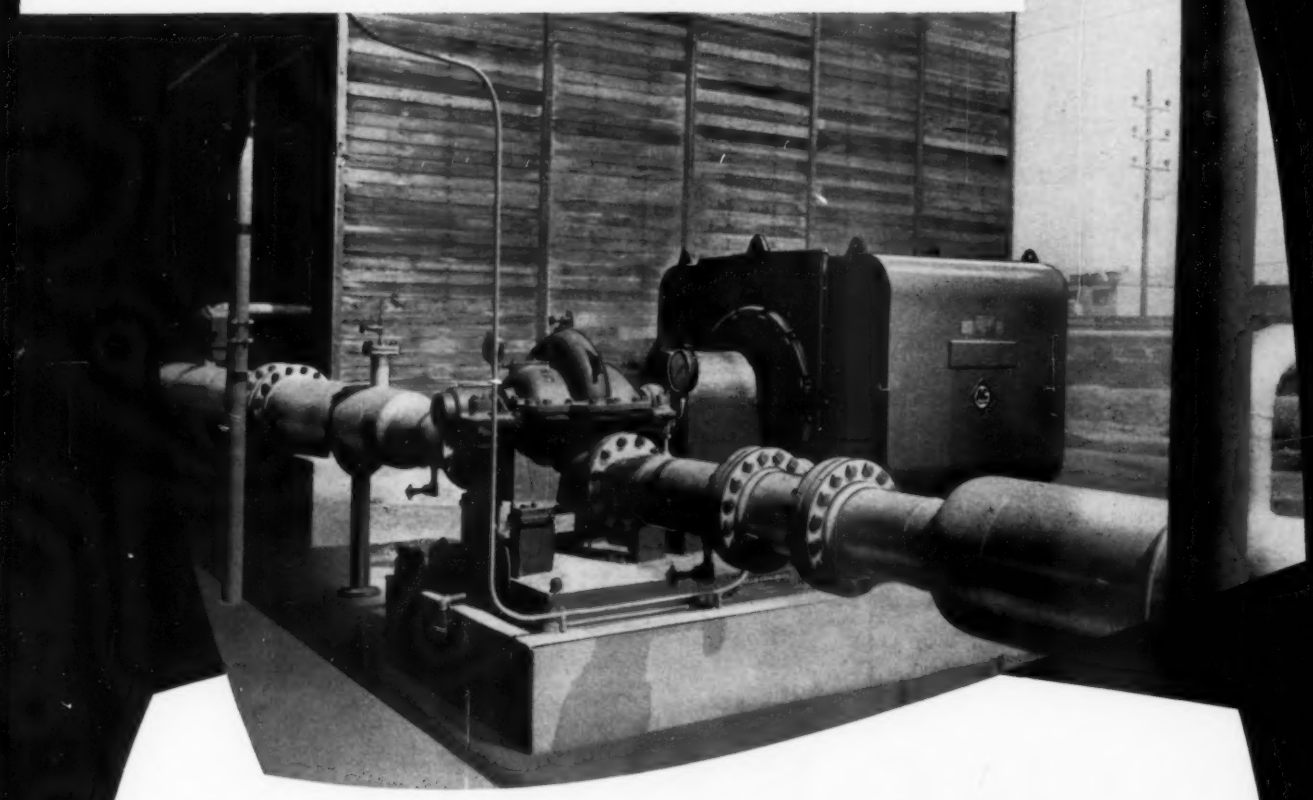

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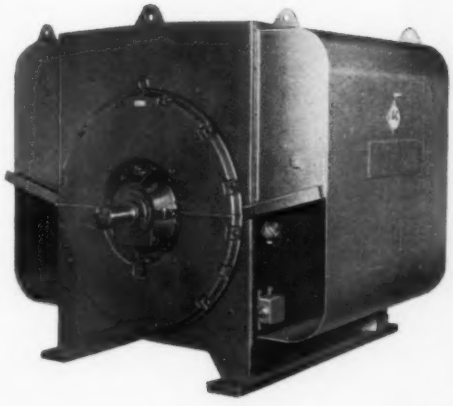

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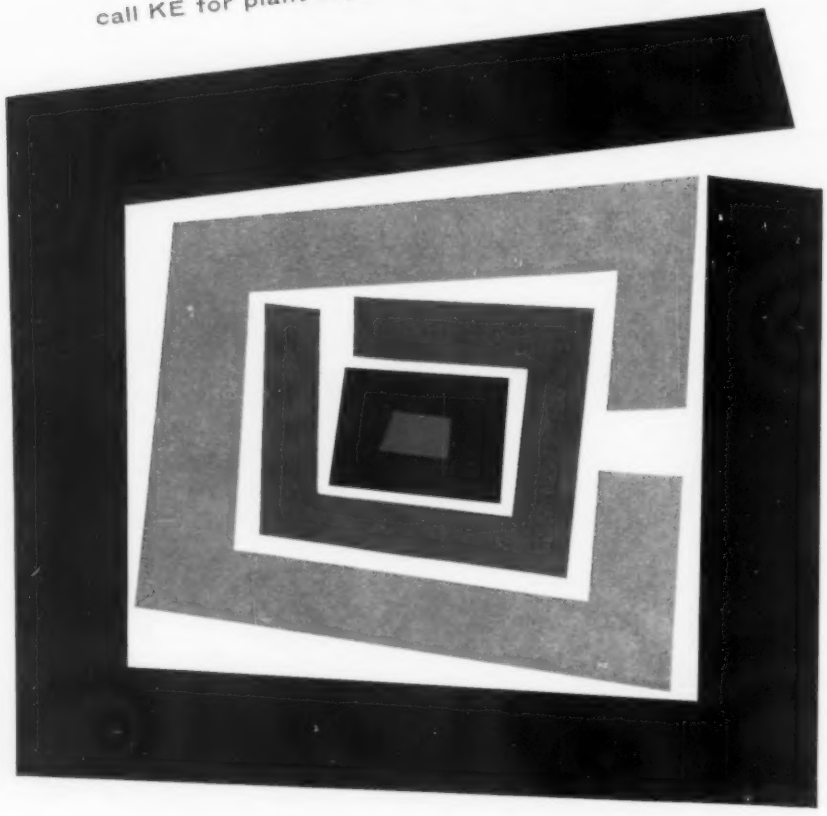

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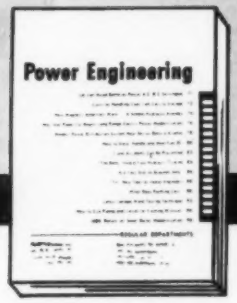

ATOMICS

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A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World Published by Technical Publishing Co.

May 1, 1958

Reactor Concepts. Of different nuclear reactor concepts there appears to be no end. As long as reactor designers have a sufficient quantity of uranium or plutonium at hand, and of course other materials as well, there seems to be no end to the different ways these things can be put together to make nuclear reactors.

They can be absurdly simple, or inordinately complex. The world's first reactor -- Fermi's pile under the West Stands of Stagg Field at the University of Chicago -- was very simple. It consisted merely of a pile -- and that is where the term atomic pile originated -- of graphite blocks in which a large number of pieces of uranium metal and uranium oxide were arranged according to a lattice pattern that had been arrived at partly by preliminary experiment and partly by computation. This pile went critical, or as our British friends say, it diverged, on December 2nd, 1942.

Everything that has evolved in the field of nuclear development in the years since 1942 stems from the success of that initial experiment. The whole success or failure of that experiment depended upon the multiplication factor, k, sometimes called the reproduction factor. If k could be made greater than 1 in a practical system, the project would succeed; if not, the chain reaction would never be more than a dream. If that experiment had failed there would have been no atomic bomb, and there would be no nuclear power industry today.

Fermi's pile was operated for such a short time and at such low power that it required no cooling, and the radiation was of such a low order that no shielding was necessary to protect the scientists who worked around it from the rays. It did, however, function for a sufficient period of time to prove that a nuclear chain reaction in natural uranium will produce as a by-product a new element, unknown in nature, called "plutonium," which, like uranium-235, is a highly efficient nuclear fuel capable of being used as an atomic bomb material. That, of course, was the object at that time--the production of plutonium for atomic bombs; the fact that heat was also produced was incidental, indeed the disposal of the heat in the subsequent Hanford reactors imposed a problem of major magnitude.

So this reactor was very simple. Except for the uranium and the pure graphite which was needed, its cost was low. What makes modern power reactors so costly are the cooling systems, the heat transfer equipment, the sensitive control apparatus, the thermal and biological shielding, and the many rare and exotic materials used to prevent corrosion and enhance neutron economy. Actually, reactors can be made much more simple than even Fermi's pile. The bare plutonium critical assemblies, Topsy, Jezebel, and Godiva, evolved in the experimental work at Los Alamos Scientific Laboratory, for example, consist essentially of two sub-critical pieces of plutonium or U-235 arranged so that they can be brought together to form a critical mass. True, such reactors are not useful except for experiment, and they are dangerous unless used with great care, but they are

nuclear reactors. The atomic bomb is a nuclear reactor built on this basic principle.

But Power Reactors are horses of different color. They have become exceedingly complex in every possible way, from the mechanical design and metallurgy of their fuel elements to the cooling and control systems, to the shielding and precautions necessary to protect personnel, and, last but not least, to their economics. Indeed, the economics at the present time is considerably more baffling than most of the nuclear mathematics.

And so, today, we have thermal, epithermal, and fast reactors; we have natural and enriched uranium reactors; we have reactors cooled by water, heavy water, gas, liquid metals, fused salts, etc; we have heterogeneous and homogeneous reactors, reactors moderated by graphite, heavy water, beryllium; reactors involving primary and secondary cooling and heat exchange systems, and so on -- the combinations are all but endless. Some years ago, Dr. Alvin Weinberg[1] made up a tabulation listing the possible combinations with various fuels, fertile materials, moderators, coolants, etc, and came up with 1728 different types of reactors, but even this list could be extended.

It is not surprising, therefore, that those not familiar with progress in the nuclear field should be somewhat confused by the great variety of reactor concepts and by the mechanical complexity of some of them. Power engineers familiar with the design and construction and heat releases of large boiler furnaces must find the precision and intricacy of some of the fuel element assemblies astonishing. For some of these fuel assemblies involve a degree of precision in machining and fitting more associated with watch making than with heat transfer equipment. Naturally such precision is extremely expensive.

Complexity comes first. The history of the development of most mechanical and electrical, and perhaps chemical devices and systems, usually discloses that the first practical arrangements are complex, and then, as development proceeds, the tendency is towards simpler arrangements. Sheer size, of course, introduces a degree of complexity of its own, as in the case of a large electric power station, but basically, the equipment itself is simpler. A steam turbine basically is simpler than the steam engine. The modern airplane is another example; compare the smooth simplicity of the modern monoplane with the terribly complicated array of wings and rudders of Santos Dumont's early models.

It is quite likely, indeed almost certain, that there will be a similar trend toward simpler reactor systems in the future development of nuclear power. Already, some of these simpler concepts are making their appearance. The first practical reactors were water cooled. These were the large plutonium production reactors at Hanford. Water is an excellent heat transfer medium so it was natural for the designers of the first power reactors to turn to water as a coolant and heat transfer medium. At that time it was thought that boiling in such a water-cooled reactor would be detrimental, that it would lead to instability, indeed, no one had any idea of what might happen. Furthermore the steam resulting from such boiling would inevitably be radioactive and this would introduce hazards which could not be tolerated.

So the pressurized water reactor was devised wherein the water coolant was under such high pressure -- 1000 to 2000 psi -- that boiling would not take place. This system involves primary and secondary loops and requires extremely expensive, heavy walled pressure vessels. Later sodium cooled reactors were thought of and in England gas cooling was adopted. Gas cooling also entails primary and secondary circuits.

Although the idea of a boiling water reactor had been in the minds of a few scientists as early as the old Hanford days, it was not until around 1948 to '50 that serious thought was given to the design of such a reactor and

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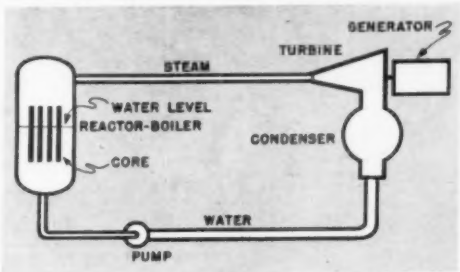
[1] ATOMICS, December 31, 1955

that some preliminary experiments were made concerning the heat transfer rates that might be achieved. This first work at Argonne National Laboratory subsequently led to the famous Borax experiments at the Idaho Testing Site of the Atomic Energy Commission, and the success of the Borax tests led to the design of EBWR, the 5000-kw (e) Experimental Boiling Water Reactor at Argonne. The Vallecitos Boiling Water Reactor of the General Electric Co, and the design of Dresden Station of the Commonwealth Edison Co now under construction also is based upon the boiling water concept.



Simplicity of BWRs. As shown in the diagram at the right, nothing could be simpler than the boiling water reactor. It consists simply of a reactor-boiler directly connected to a turbine and condenser. Condensate is pumped back into the reactor by the pump. The pressure vessel need be designed only to carry the working steam pressure, pumping power is much less than for the pressurized water system, and the radioactivity of the steam is very much less than was originally supposed. It need give little trouble.

Of course, many things remain to be learned about boiling water reactors but their inherent simplicity and resulting low cost should do much to put this type of system in the running for competitive nuclear power. The fact that the boiling water reactor is self-regulating is an additional factor in its favor from the safety standpoint. With the recent development of oxide type fuel elements, corrosion problems also will not be serious. With such oxide fuel elements it is possible that the present temperature limits will be raised; and studies are now going on on the design of boiling water reactors incorporating steam superheating sections.

Dust Fueled Reactor Concept. Another reactor concept that has interesting possibilities is The Armour Dust Fueled Reactor (ADFR) being investigated at the Armour Research Foundation of Illinois Institute of Technology. This involves a new fuel form -- fissionable dust carried in an inert gas. It has all the advantages of any fluid fueled system with greatly reduced corrosion and inherent high temperature capability. Temperatures of 2000 to 3000 F appear feasible in an all-ceramic system. According to D. Krucoff and F. Narin who presented a paper on this system at the American Nuclear Society meeting in Chicago in March, thermal breeding seems assured due to the virtual elimination of neutron poisons.

The Dust Fueled reactor is analogous in many ways to the LMFR (liquid metal fuel reactor). The core can be simply a block of ceramic moderator material such as graphite or beryllium oxide with through holes for passage of the fuel-laden helium. For chemical compatibility, if graphite is used as the moderator, the fuel dust would be uranium carbide and the ducts and chambers in contact with the fuel would be lined with a carbide such as silicon carbide. If beryllium oxide is used as the moderator, the fuel dust would be uranium dioxide and the lining material could be aluminum oxide.

Both externally and internally cooled versions of the ADFR have been considered. The externally cooled type permits the simple core mentioned above and has very high heat removal capabilities. A sketch of the externally cooled system is shown in Fig. 1. High temperature fluid leaves the core and plenum chamber and enters a cyclone separator which removes all particles larger than 10 microns from the fluid. These might arise from decomposition of the ceramic lining. The fluid next enters a heat exchanger or boiler in which useful heat is extracted. Following the heat exchanger, most of the fluid enters a blower and is recirculated, while a small fraction of the flow is passed through a fission product removal system.

Figure 2 show the internally cooled scheme. Pure helium is used as a coolant and is separated in the core from the fuel-bearing helium by tubes of moderator material. These tubes will not be gas tight but by maintaining the pure helium system at slightly higher pressure than the fueled region, leakage will

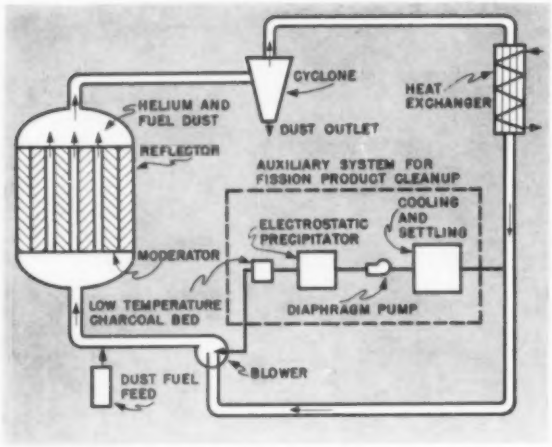


Fig. 1. Externally cooled system

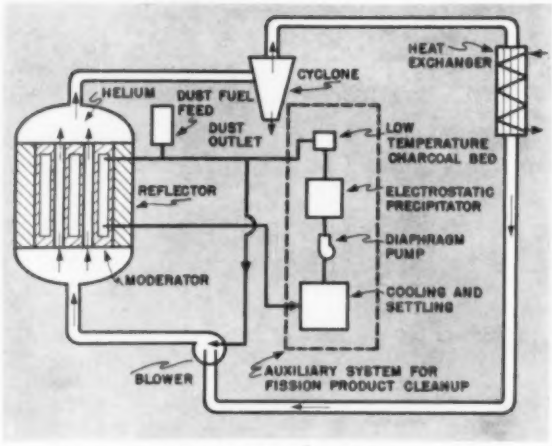


Fig. 2. Internally cooled system

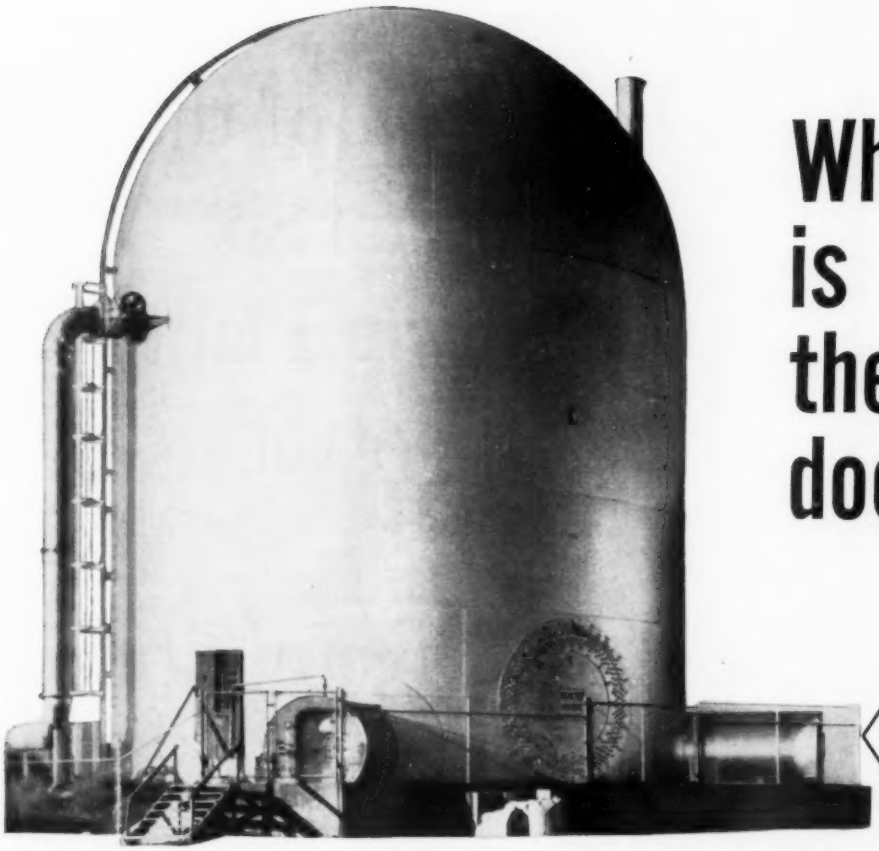
be into the latter. Excess helium would be removed in the fission product cleanup system and returned to the primary loop. The use of moderator material to separate the fuel and coolant retains the high neutron economy of the externally cooled system.

Suspension Stability. Fuel dust particles of very small size should provide suspension stability. Stokes law shows that for uranium carbide in helium, 1 micron particles have a terminal velocity of 0.03 cm per sec, and that this is proportional to the square of the particle diameter. Thus only a small vertical component of gas velocity is required to entrain very fine particles. Average particle sizes of 1 or 2 microns are obtainable and these are expected to be markedly reduced during reactor operation due to mechanical attrition, the fission process itself, and radiation. The most powerful of these will probably be the fission process since fission products have a range of about 5 microns in solids and thus will be ejected from the particles. The average size of the particle size in the core is expected to be considerably below 1 micron. For such small sizes the required entrainment velocities are so low that in the internally cooled reactor the thermal convection currents alone will probably maintain the suspension.

Good Heat Transfer. Heat transfer from the dust to the helium carrier is excellent since dust fuel has a very large heat transfer surface and introduces thermal spikes, or very high local temperatures into the fluid. In the externally cooled system power density in the core is limited only by the heat removal rate which in turn is limited by fluid velocity due to erosion.

For electric power production, requiring steam at 1000 to 1200 F, a heat exchanger resembling a conventional metallic boiler could be used with high temperature helium replacing about the same temperature combustion gas. For higher temperature process heat, a ceramic heat exchanger would be required. Double wall design appears promising for prevention of fission product leakage since, at 2500 F and above, essentially all heat transfer is through radiation. Helium could be circulated between the two walls to sweep away any fission products leaking through the first wall, so that process steam contamination could occur only by leakage through both walls and the intermediate sweep gas region.

The use of entrained dust as fuel is particularly attractive in the area of control. Removal of fuel dust from the core by fluid expansion, as well as moderator expansion, results in a large negative temperature coefficient, which should provide stability of operation. Finally, maximum neutron economy is attained by the elimination of many neutron poisons normally present in a reactor, such as control rods, fuel element matrix, cladding material, structural material, and much of the fission products. Breeding should therefore be possible using the thorium-uranium^{233} cycle. All in all, this concept looks promising.



Where is the door?

These two tubular entrances are the Pratt Air Locks in the Vallecitos Boiling Water Reactor at the General Electric Vallecitos Atomic Laboratory at Pleasanton, California.

The Henry Pratt Personnel Air Lock

provides easy passage in and out of containment vessels in full compliance with the AEC code for reactor construction.

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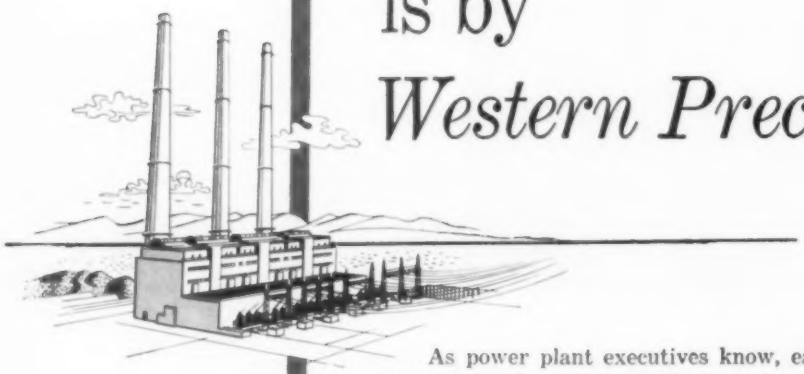

As power plant executives know, each year the Federal Power Commission "rates" the nation's major steam power plants to determine their overall efficiency as determined by their heat rate.

According to the latest Federal Power Report, the "Top Six" steam power plants are . . . 1. Tanners Creek Plant (Indiana and Michigan Electric) . . . 2. Kanawha River Plant (Appalachian Electric Power) . . . 3. A two-way tie between Muskingum River Plant (Ohio Power) and Kyger Creek Plant (Ohio Valley Electric) . . . and 5. A two-way tie between Clifty Creek Plant (Indiana-Kentucky Electric) and St. Clair Plant (Detroit Edison).

Obviously, to qualify among the nation's best, these plants represent not only advanced engineering design but also the most painstaking evaluation and selection of equipment. *And we at Western Precipitation take particular pride in the fact that—for the second straight year—the equipment selected for fly ash control in EVERY ONE of the top six plants is Western Precipitation equipment!*

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Hall Industrial Water Report

VOLUME 6 MAY 1958 NUMBER 3

Steel Production at New High

The day is not too far off when we shall be reading headlines like this. And when we do we shall know that again steel manufacturing facilities are being pushed to the limit and that avoiding unscheduled outages is of paramount importance.

Uninterrupted operation requires an effective water treating program whether the plant is a giant or a midget and whether the product is steel or silk stockings. That is why so many plants retain Hall Laboratories to help them avoid and solve problems with boiler water, cooling water, service water, process water and waste water.

Hard Water in Condensate

When a steel mill installed new boilers the old hot-process, lime-soda softener was retained to treat the make-up water. After a short period, operators were faced with the fact that phosphate consumption was far in excess of what it should have been. Checks showed that the softener was working properly, so hard water had to be entering the system at some other point. But where?

The search for the source of the hard water contamination was finally rewarded with success. In the old power plant, available condensate had been pumped into the raw water inlet line to the softener at a point down stream from the control valve. In the new plant the turbo-blower condensate was pumped into the deaerating heater. The old condensate piping was not removed and was merely extended to the heater. Since less pressure was required to pump the condensate to the new location than to the old, it went to the heater. But along with it went raw water which flowed in reverse through the old condensate piping.

It was easy to eliminate the trouble by blocking the old condensate line after the hard part of tracing down the source had been accomplished by the Hall engineer with the help of the operators.

Cleaner Waste Water

A foundry clarifies hydro-blast water before reusing it or discharging it to waste. Standard procedure was to use aluminum sulfate as the coagulant with activated silica as a coagulant aid. This produced a water of less than satisfactory quality at a high cost.

The Hall engineer substituted a Hagan Coagulant Aid for the activated silica. This not only produced an effluent of greatly improved clarity but did so with almost 75 percent less aluminum sulfate. An added bonus was the ease of preparing the Hagan Coagulant Aid slurry as compared to the care required in mixing the activated silica sol.

"Obvious" Diagnosis Wrong

On a routine visit to an eastern steel fabricating plant, Hall engineer J. T. Waldron found the water in the new high-pressure boiler to be badly contaminated with salt. A check on the zeolite treated make-up water showed this was not the source. Then the condensate from the surface condenser was found to be high in chloride. The obvious conclusion was that the condenser was leaking and allowing contamination of the condensate with the salt water used for cooling.

Waldron had been fooled before and was not ready to accept the obvious answer. He looked further and discovered the real trouble. The low-pressure end of the turbine was sealed with steam through a connection at the top of the seal; at the bottom was a drain connected to an eductor activated by salt water. Insufficient steam was being supplied to the seal, so the vacuum in the turbine outbalanced the vacuum produced by the eductor. Salt water accordingly backed up from the eductor through the steam seal into the turbine. More steam to the seal and a little less salt water to the eductor solved the problem.

Correct diagnosis here was indeed fortunate. If the "obvious" had been accepted the operators would have had an emergency shutdown of the turbine to check the surface condenser. Then they would have been dismayed to find no leaks and no answer to their difficulty.

Steel Without Spots

The galvanized strip steel from a Pennsylvania mill developed large discolored spots some weeks after shipment. Because of their concern over this serious problem the operating men enlisted the aid of everyone who might be able to help them.

Hall Engineer B. Q. Welder was asked for his opinion. From his experience with metal cleaning, he suspected the rinsing operations. Following galvanizing the strip was spray rinsed with filtered river water, dip rinsed with the same water and then rinsed in a sodium chromate-sodium silicate solution prepared with river water. Welder's opinion was that the solids in the rinse waters were drying on the metal. When a humid atmosphere subsequently produced condensation and solution of the salts, they reacted with the zinc coating, discoloring the metal surface. A confirming factor was the increase in seriousness of the spotting in inverse ratio to the gauge of the strip. Lighter gauge material traveled faster through the equipment and carried out more water.

A condensate rinse was added just ahead of the chromate-silicate rinse and condensate was substituted for river water in preparing the latter solution. The problem was solved.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

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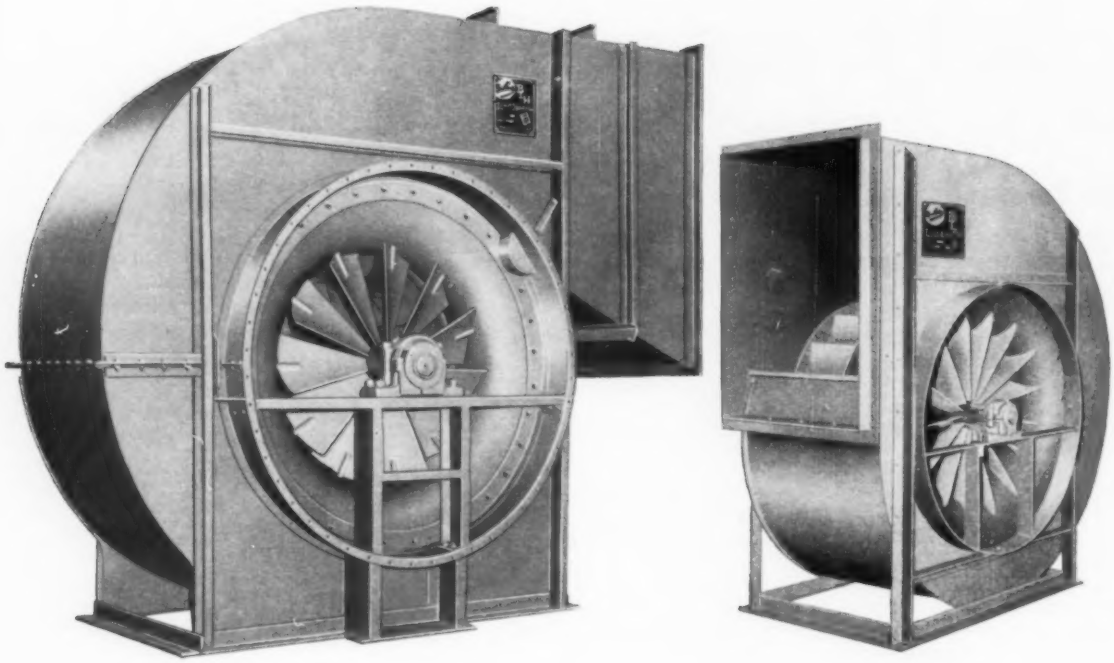

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BLH—For Classes III and IV Service

Outstanding performance has characterized the "Buffalo" Type "BLH" Fan in a large number of Classes III and IV mechanical draft applications. A high mechanical efficiency is maintained over a wide operating range. Stability of performance is constant from free delivery to shutoff. In the "BLH" turbulence is reduced to a minimum by a combination of "Buffalo" features: smooth inlet bell, backward-curved blades, uniquely-curved rotor flange and divergent outlet. Traditionally superior "Buffalo" engineering and rugged construction insure top performance, extreme dependability, quiet operation and a long, maintenance-free life.

For full information on the "BLH", contact your "Buffalo" engineering representative, or write for Bulletin F-200.

BL—For Classes I and II Service

The high performance record of the "Buffalo" Type "BL" Fan is firmly established for most mechanical draft service in Classes I and II. Featuring non-overloading power characteristics, it provides stable, quiet output from free delivery to shutoff. A number of "Buffalo" engineering features contribute to the efficiency of the "BL". These include the "Buffalo" designed wheel, factory-balanced and tested to minimize vibration, and the wheel-suited housing's "free-flow" scroll design. The smoothly curved inlet bell is a strong factor in reducing turbulence.

Your "Buffalo" engineering representative will be glad to explain all the advantages of the "BL" — or write direct for Bulletin F-102.

Every "Buffalo" Fan brings you the advantages of the famous "Q" Factor — the built-in QUALITY which provides trouble-free satisfaction and long life.

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Buffalo Pumps Division, Buffalo, N. Y.
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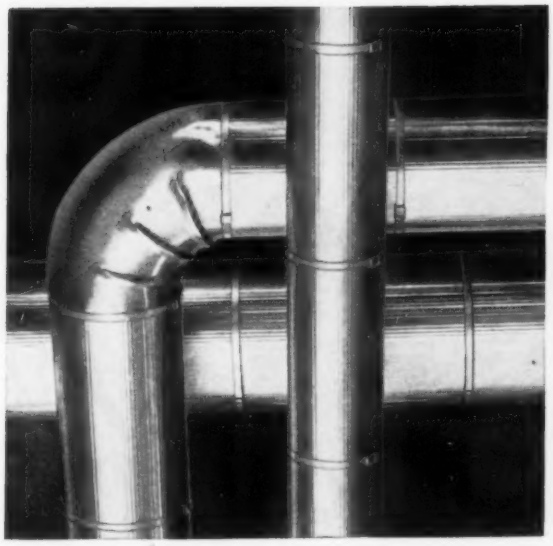

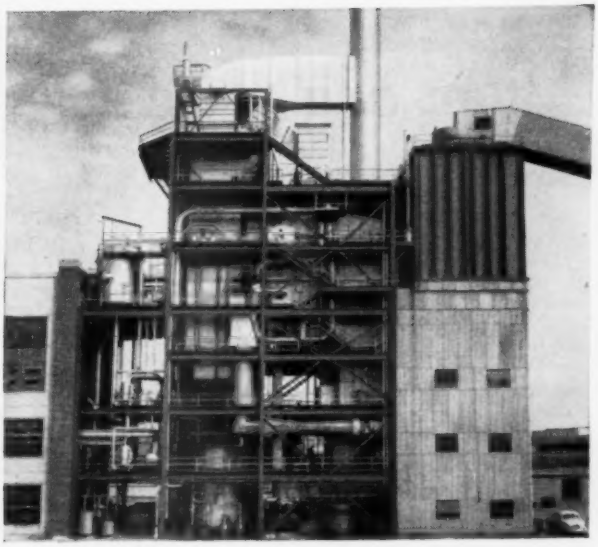

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Maintenance-free Childers Jacketing goes on fast and easy . . . never needs painting . . . gives steam lines the well-dressed look that good housekeeping demands.

Insulation lasts far longer, say leading power plant engineers, when protected with Childers Aluminum Jacketing. Costly maintenance and repairs to insulation are reduced, and insulation is protected against damage from workmen, moving equipment and dripping fluids like oil and grease.

Heat lost by radiation is reduced, too, when Childers Jacketing is installed on power plant lines and equipment. The improved efficiency of the insulation decreases fuel consumption. Fewer BTU's are lost per KWH.

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Greater strength at less cost is yours with Childers Cross-Crimp®. Tests prove the rolled-in 3/16" cross corrugation increases the vertical strength and rigidity of .016" thick aluminum to that of plain .024" thick aluminum. Jacketing costs are consequently reduced as much as ⅓ when Childers Jacketing is used instead of ordinary sheet aluminum.

You can complete the installation of neat, maintenance-free aluminum over every square foot of valuable insulation by using new Childers Ell-Jacs. These two-piece aluminum covers are available for insulated elbows up to 16" o.d., including insulation thickness. For larger elbows, regular roll jacketing is easily mitered on the job and applied.

First cost is less for Childers Jacketing and Ell-Jacs than for any other permanent-type protection—even less than some temporary coverings which require constant maintenance, repair and replacement.

Installation is easy. Two men can do the job. Best method of attaching jacketing is with aluminum strapping and seals. Only pliers and screwdriver are needed. Childers Ell-Jacs are applied with aluminum sheet metal screws. Jacketing and Ell-Jacs can be removed to inspect lines, then reapplied without waste.

Engineering Representatives in 27 cities provide technical information and assistance on protection of insulated lines, elbows, towers, vessels, tanks. Only Childers has this nationwide service organization.

For a free sample of Childers Jacketing, with engineering data on how to safeguard your insulation, write to: Childers Manufacturing Co., P. O. Box 7467, Dept. PE-2, Houston 8, Texas.

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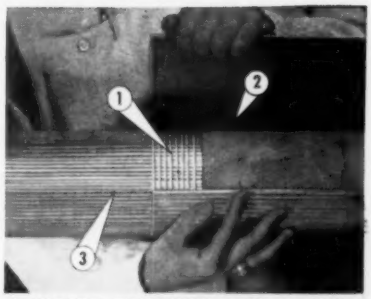

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HEAVY WEIGHT Childers aluminum jacketing is recommended for extra protection of lines along walkways and other areas subject to physical abuse. Also recommended for protection of insulated towers, vessels, and tanks. Comes in labor-saving 4' wide rolls.

Only Childers makes available to you complete specifications and engineering data on aluminum jacketing in these catalogs: Sweet's Industrial Construction File pp. 6b/Ch; Chemical Engineering Catalog pp. 530a-d; Refinery Catalog pp. 341-4.

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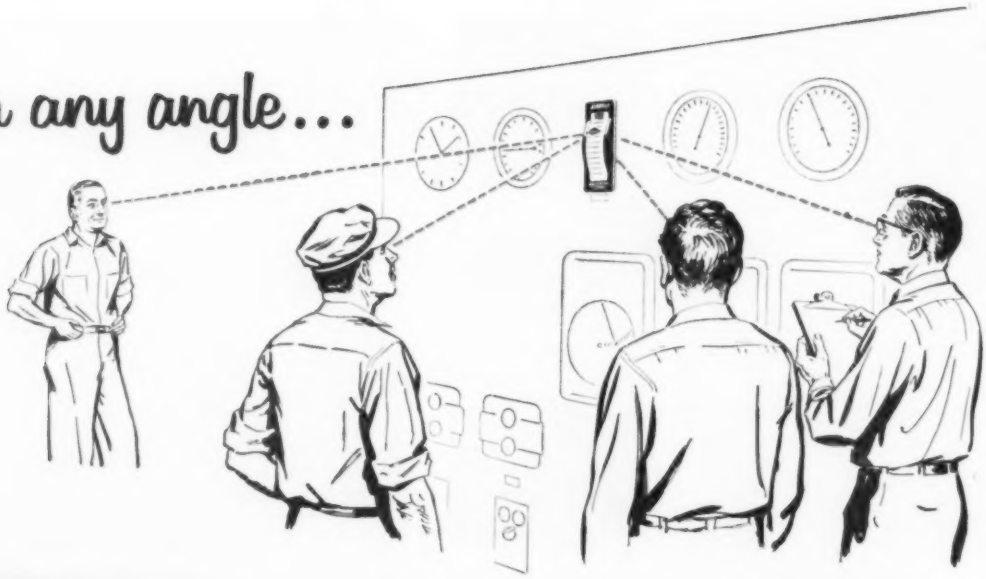

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TRACERS

Power Engineering's Monthly Probe of Power Facts

Joseph Kaye and George N. Hatsopoulos, professors at MIT, believe they have invented an engine which will convert atomic heat directly into electricity. They call it a thermo-electron engine. It operates without any mechanical moving parts, on the principle that if two metal plates are placed side by side and one is made hotter than the other, electrons jump from the hot plate to the cold plate, forming a stream of electricity. Ordinary fuels, nuclear fuels, or solar energy could be used, with isotope heating also a promising possibility. A model has produced electric power with thermal efficiency of about 12 per cent.

With proper equipment, it is possible to recover as much as 95 per cent of the heat in blowdown water. But what is "proper equipment"? The new heat recovery system described step by step on pages 72-73 of this issue is one good answer.

A. J. Haagen-Smit of CalTech, researching on flue gas analysis at El Segundo station of Southern California Edison Co, reports successful long-term operation of a Beckman model 21 infrared analyzer for detecting sulfur dioxide and nitric oxide. The device gives a continuous record rather than the grab samples required by chemical methods. Response of the infrared is practically instantaneous.

Engine of over 1000 hp, which can easily be carried by two men, was described at ASME's recent meeting on gas turbine developments. Engine's horsepower to weight ratio is an amazing 4 to 1. It was designed primarily for helicopters but can be adapted readily to other uses. See the report on page 79.

Graphite, niobium carbide and zirconium carbide have the highest melting points of any known material which might be suitable for use in reactors (low thermal neutron absorption cross section). This has been discovered by a design team at Nuclear Development Corp of America. Sublimation point of graphite is about 6700 F. Niobium carbide and zirconium carbide have melting points of 6800 F and 6400 F.

After three years of testing in high-voltage power systems, vacuum interrupter switches have proved themselves for long life and reliability. Low cost, half-cycle interruption, and no restriking are other features. H. H. Schwager's summary account of this important new device (page 59) shows its use today on 10 systems.

Annunciator system with no moving parts — for utility generating stations — will get its first application in the big new power station at Bergen, N. J. It will be used there to monitor 560 critical quantities. Developed by Westinghouse, the system uses modular plug-in magnetic elements rather than relays. Advantages center on the long life and reliability of magnetic elements, also on better testing.

Governors Regulate Turbine and Engine Speed and Load

Authors review the fundamentals used in controlling prime movers, and discuss the application of various principles to speed, pressure and load control. Various types of governors are considered

By A. W. CAREY, Jr.* and D. G. MARK*

WEBSTER DEFINES a governor as "an automatic attachment to an engine or turbine to control its speed". However, the field of governing in its true sense is not as limited as this definition implies. Liquid- and gas-pressure regulators and voltage regulators are but two examples of controllers employing the governor principle which do not control a shaft speed.

Therefore the authors prefer to define a governor as a device which holds a quantity constant or restricts its variation within close limits by means of forces arising from deviations of that quantity. However, this article will deal principally with shaft-speed governors for prime movers.

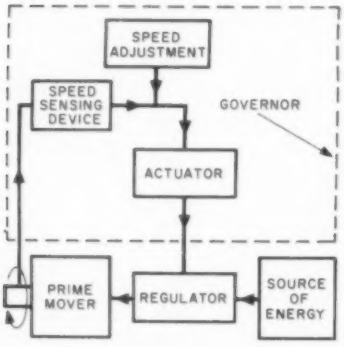


Fig. 1. Diagram of a basic speed governing system used on a prime mover

Fundamentals

A block diagram of a basic speed-governing system for a prime mover appears in Fig. 1. System shown here schematically will perform the governing function, although certain additions and refinements greatly improve its operation, as will be described later. Prime mover appearing in the diagram is any device for transforming thermal or hydraulic energy into mechanical energy, and might be either a reciprocating piston engine or a turbine. Source of energy supplying a particular prime mover might be steam, liquid or gaseous petroleum fuel, or water having a hydrostatic head.

Interposed between the prime mover and its source of energy is a regulator such as a throttle or some similar means for controlling the rate at which energy is supplied to the prime mover, and thus its power output. A governor functions by monitoring the speed of rotation of the output shaft, comparing it with a speed setting, and making the necessary adjustments to the regulator to cause the two to agree.

Since the output power of a prime mover is a function of shaft torque, as well as speed, a governor used to control the rate of energy input to the prime mover actually governs both of these factors.

Governor can be arranged to hold one or the other constant, or it can be used to control energy input at a rate based on some external factor, such as the output of the prime mover load, as shown in Fig. 2. An example of such an application involves the use of a governor to maintain a constant discharge pressure on a pump or compressor by varying the speed of the drive shaft.

Another variation in governing systems is shown in Fig. 3. There the input energy is supplied to the prime mover at a constant rate, and the governor operates on the load to maintain a uniform shaft speed.

Watt's governor, shown schematically in Fig. 4, is driven by the engine, so that the flyballs revolve about the governor shaft at a speed that is in fixed relation to that of the crankshaft. If the speed increases, the flyballs move out further from shaft, raising the collar which increases the restriction to fuel or steam flow, and hence tends to return the speed to its original value. A decrease in speed would, of course, cause the flyballs to move in so that the throttle would be opened, tending to raise and restore the speed.

Analysis of Figs. 1, 2 and 3 shows that the power required to actuate the regulator of the prime mover in

*Battelle Memorial Institute, Columbus, Ohio

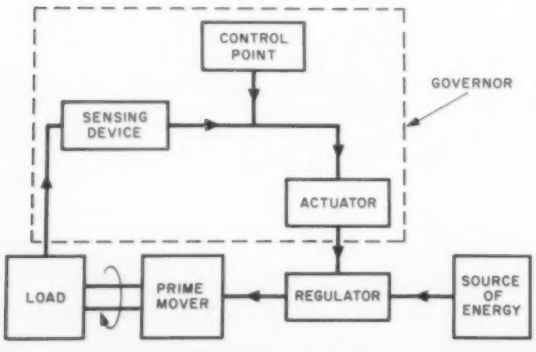


Fig. 2. Governor control based on load output instead of speed

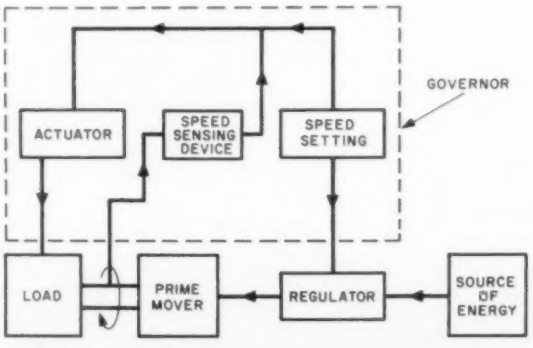


Fig. 3. Control of load instead of throttle for constant speed

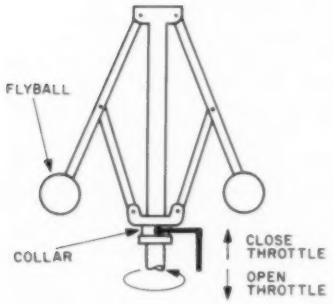


Fig. 4. Basic scheme of Watt governor

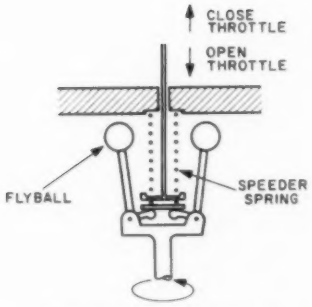


Fig. 5. Ballhead with a speeder spring

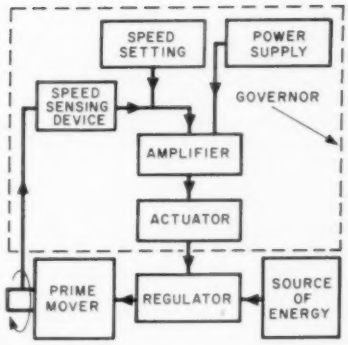


Fig. 6. Block diagram of a conventional servo type speed governing system

the simple governor system must come from the output shaft of the prime mover, being transmitted indirectly through the ballhead or other speed-sensing device. The sketches of ballhead governors appearing in Figs. 4 and 5 show that a governor is basically an energy storage device, having the capability of storing energy both in the rotating ballhead and in the partially compressed speeder spring.

When the prime-mover shaft is rotating at a constant speed, a balanced condition exists, with energy stored in both locations. If a shift in load causes the speed to change, the component of centrifugal force opposing the speeder spring will not equal the speeder spring force. This difference in force is then available to act on the regulator to increase or decrease the flow of fuel.

It becomes obvious that if speed changes are to be kept to satisfactorily low levels, either the energy derived from the ballhead-speeder spring system to energize the actuator must be kept at a very low level, or the system must be massive enough to store a sufficient amount of energy to permit it to supply adequate power to the actuator.

For prime movers in which the power needed to actuate the regulator is quite small, this requirement imposes no hardship, but in applications like water wheels where a comparatively large amount of power is needed to control the input energy to the unit, the governor would need to be huge indeed.

In addition, a reaction on the ballhead from the actuator prevents the ballhead from fully responding to a speed change of the prime mover, causing even the smaller units to have an excessively wide dead band, or range in which the speed can vary without resulting in a corrective motion of the energy regulator.

Fig. 6 shows the means by which nearly all the load is removed from the ballhead, greatly increasing the sensitivity of the governor. The output of the ballhead is used to drive a power amplifier, the output of which moves the actuator for the throttle. It will be noted that the power used to move the actuator comes from a separate power supply and is not transmitted in any way through the ballhead. The addition of this power amplifier results in the servo-type governor.

In the vast majority of today's servo governors, the amplifier is a spool-type pilot valve, and the power supply is a hydraulic pump driven by the prime mover. The actuator becomes merely a pressure-operated piston.

Terminology

At this point the language and terminology can be conveniently introduced. The purpose of most speed governors is to hold the prime mover speed as nearly constant as possible. The goal, perfectly constant speed, is known as *isochronism* and is achieved in today's servo-type governors.

When the governor permits the speed to vary with load, it is said to have droop. All of the simple flyball governors have droop, which can be varied on either side of isochronism with some of the modern servo governors. Increasing speed with decreasing load is termed positive droop while the opposite situation is known as negative droop. Although negative droop can be obtained in a governor mechanism, it is so seldom encountered in practice that it can be regarded as a curiosity.

Closely related to droop is the term *regulation*, which expresses the difference between no-load and rated-load speeds as a percentage of the rated-load speed.

A look at the sketch of an elementary ballhead can easily lead one to the conclusion that in it and the prime mover are the ingredients of an oscillatory system. Actually, in many systems there is enough damping to keep this from being a problem. In others, however, there may be instability in the fuel system itself, so that opening the throttle slightly may actually lower the power potential. This has been observed particularly where mixture ratios change, as in a gas engine that is not properly adjusted.

To overcome excessive oscillation in properly adjusted prime movers, the governor builders have resorted to compensation. Through compensation the correction is anticipated and over-correction is minimized, thus permitting a return to speed without excessive over or under shooting.

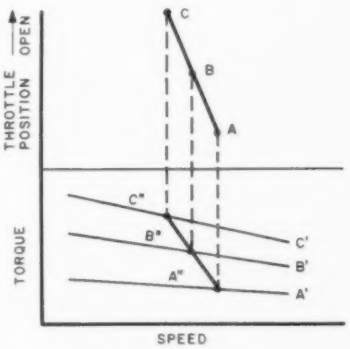


Fig. 7. Method of determining torque-speed curve of governed prime mover

Most of us have observed hunting engines. The term hunting, as frequently used, refers to the continued oscillation of speed above and below the desired value. It can be stopped by restraining the throttle but will reappear when the throttle is released.

Similar phenomenon is the surging prime mover. Its speed will oscillate until the throttle is restrained, but, unlike the hunting prime mover, it will not resume oscillation unless disturbed again. In actual applications it is frequently difficult to distinguish between hunting and surging.

Principles

Now that we have discussed the kind of control a governor can exercise over a prime mover and have introduced some governor terminology, a look at the principles of operation is in order. Figure 7 explains graphically how both prime mover characteristics and governor characteristics are important in determining the torque-speed curve of the total machine. Straight lines have been used rather than curves for the sake of simplicity and clarity.

Line A-B-C gives the positions that the governor's throttle control arm will assume as the speed is varied. The speeder-spring setting is the same for all points on the line A-B-C. Lines A′, B′, and C′ show the relationship between torque and speed for the three specific, fixed throttle positions, A, B, and C.

Superimposing the governor's position-speed line on the prime mover's fixed throttle torque-speed lines results in curve A″-B″-C″, which is the torque-speed curve of the governed prime-mover. An important fact to bear in mind is that there is a definite throttle position for every speed, irrespective of load, when one is dealing with a droop-type governor at a constant speeder-spring setting.

With a mechanical non-servo-type governor, the throttle is kinematically linked to the governor ballhead assembly, so that any change in throttle position must come as the result of a change in ballhead position and, hence, speed. For this reason the mechanical, non-servo governor must necessarily have speed droop.

Servo-Systems

To remove speed droop and to achieve isochronism, the kinematic relationship between the position of the ballhead and the throttle must be removed and yet the ballhead must still control the throttle. As previously described, the power to achieve this result must come from an external source.

In a patent dated 1870, A. W. Woodward officially recorded his invention of a governor for controlling the speed of a water wheel. From this governor has developed the highly precise servo-type governor of today. Fig. 8 is a schematic sketch of a simplified isochronous governor.

Hydraulic pressure is provided by an oil pump and accumulator system, usually within the governor itself. When the speed falls and the ballarms move in, the pilot valve is lowered, exposing the servo piston to the oil pressure and moving it in the direction to raise and restore speed.

If the speed were to rise above the desired value, the ballarms would move out, raising the pilot valve, exposing the servo piston to the drain and causing the piston to move down, so that the speed would be lowered and restored. Thus the governor acts to maintain the pilot valve in its neutral position and therefore, the speed constant at a value dictated by the compression of the speeder spring. A change in speed is effected by adjusting the upper stop of the speeder spring up or down.

When speed droop is desired in a servo-type governor such as that of Fig. 8, it can be accomplished by making the speeder rod length (or equivalent linkage) or speeder spring compression vary with servo-piston position.

Stabilization

It should be pointed out here that the governor of Fig. 8 is unstable in the sense that if it were undamped, it would oscillate continuously about the set point. To make it stable, compensation or temporary speed droop is required.

While the analogy may not be entirely accurate, the anticipatory effect of compensation can be visualized by imagining a ball hanging on a rubber band. If the ball is pulled down past its equilibrium point and released, it will oscillate for quite a few cycles.

If, however, the hand which holds the other end of the rubber band tends to duplicate the motion of the ball as it springs back from its initial displacement, with the proper phase relationship, the oscillation can be suppressed within one or two cycles. This action is instinctive in a human being.

A governor, on the other hand, has only those reflexes with which man endows it. To stabilize the isochronously-governed prime mover, the governor designers have conceived several methods of making the governor think the speed has been restored before it actually is. In general, compensation is achieved by permitting a signal representative of the actuator or servo-piston velocity and displacement to alter temporarily the speeder spring force, or the kinematic relationship between the ballhead and the pilot valve.

When the actuator comes to rest, the compensation fades out (usually by means of a controlled hydraulic leak) and equilibrium relationships are restored.

Application

In considering a governor for a particular application, the engineer is usually concerned about its response to a speed disturbance. The response of the governor itself can be determined through the solution of the governor transfer equation. This equation, usually supplied by the governor manufacturer, is a differential equation which takes into account not only the position of the actuator and the speeder control, but also the velocity and acceleration of the speed deviation. Constants are applied to account for the mechanical and hydraulic characteristics of each governor design.

In addition to the governor's response, however, the engineer must also consider the reaction of the prime mover: — the time between a change in throttle position and the arrival at a new equilibrium point. Both play a part in determining how well the total machine will recover from a speed upset.

Prime movers operating in parallel present a special problem. The objective, of course, is to divide the total load according to some predetermined schedule while maintaining speed within the prescribed limits.

In the discussion which follows, it makes no difference if the prime movers are geared to a common output shaft or are delivering power to an alternating-current electric system. In either case, the speed of each prime mover is positively related to that of every other unit in the system.

If some droop can be tolerated or is desired, the solution is relatively simple. This situation is shown graphically in Fig. 9. The load-speed characteristics of three prime movers having governors with positive droop are illustrated.

Prior to a load change, all are running at a speed represented by the horizontal line, Speed$_1$. Unit A is carrying a Load A$_1$, Unit B is carrying B$_1$, and C is carrying C$_1$.

Total system power output is A$_1$ plus B$_1$ plus C$_1$. When an increase in load is imposed on the system, the speed sags to a lower value, Speed 2, such that the sum A$_1$ plus B$_1$ plus C$_1$ is equal to the new load.

Note that Unit C, which had the least droop, has picked up the largest share of the load increase, while B, with the greatest droop, has picked up less than either A or C. Assuming that the droop can be varied, the load each unit would pick up or drop could be made equal by making all the droop settings equal.

In a case where the speed must not change, regardless of load, such as a utility producing constant-frequency alternating current, the situation is

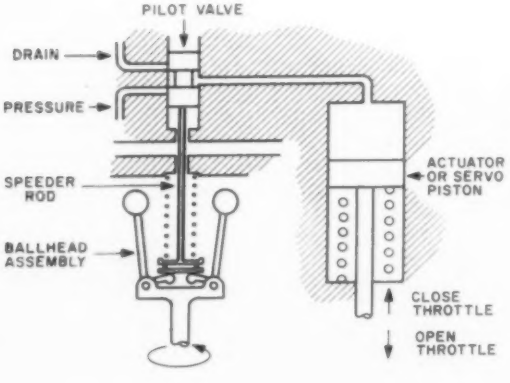


Fig. 8. Simplified sketch of hydraulic isochronous governor. Device uses external power to operate throttle

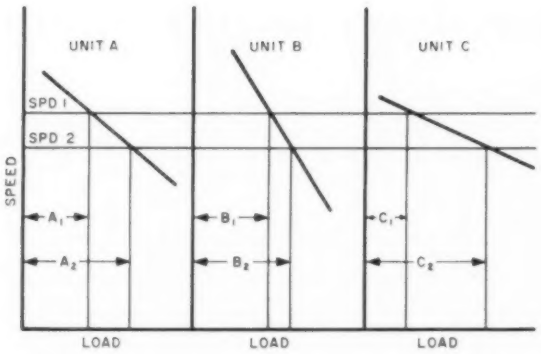


Fig. 9. Curves illustrating the parallel operation of three governed prime movers, each having a positive speed droop

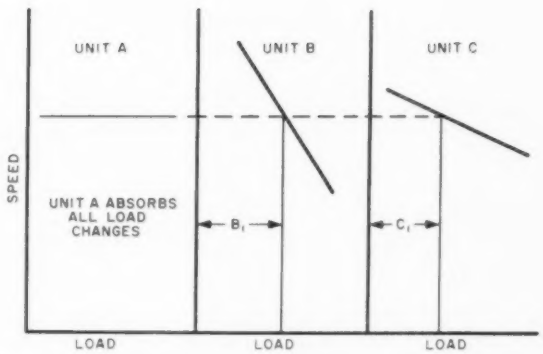


Fig. 10. Parallel operation of three governed units having constant output speed. Unit A absorbs all changes of load

different. If prime movers A, B, and C are all now isochronous and set at precisely the right speeder-spring compression, the governors will be completely confused as to how to divide the load. The answer to the problem is shown in Fig. 10.

In this case, only A is set at zero droop. B and C are no longer confused and carry loads B^1 and C^1. If all the settings are left as they are shown in Fig. 10, Units B and C will continue to carry loads B^1 and C^1 respectively, while A adjusts its power output to satisfy the system requirements. Units B and C will assist in picking up a load change during the momentary off-speed period immediately following a load change.

For example, if an additional load is imposed on the system, the speed will be temporarily depressed. While the system speed is at a temporarily lower value, the load carrying capacity of both B and C rises, thus easing the burden on A. To maintain an equitable load distribution as the total load changes, the speeder-spring settings of B and C must be adjusted either manually or by a means external to the governor.

In a fixed frequency system, a change in the speeder-spring setting of any of the units which do not maintain frequency will result in a change in the load that unit carries. Increasing the speeder-spring compression will increase the load the unit carries. To put it another way, while the isochronous governor has relieved the operator of the necessity of being a watchdog over system frequency, it has not relieved him of the responsibility for monitoring the load division between units.

Electrical Speed Governors

A governing system need not necessarily be mechanical, however, for there are other commonly-used types of equipment that are capable of performing these same functions. A corresponding governing system can be assembled, for example, from electrical and electronic components. An examination of an electrical governor will show, however, the reason why it has not as yet seriously challenged the supremacy of the mechanical governor.

The speed-sensing device most often used in an electrical governing system is a voltage generator of either the alternating-current or direct-current type, called a tachometer generator. The magnitude of the output voltage of the direct-current tachometer is very closely proportional to the speed of rotation.

However, in the alternating current-tachometer, while the amplitude of the alternating output voltage is also approximately proportional to speed, its frequency is exactly proportional to speed. The generators used are small instrument-type devices having negligible power capabilities, since their output information usually must be processed in some manner before it can be used to drive the actuator.

Voltage or Frequency?

If the tachometer generator is of the direct-current type, the output potential is usually compared with the manually-adjusted direct potential that is equal to the tachometer output at the desired speed. If the speed of rotation is correct, the net output voltage of this comparison circuit is zero, while deviations in speed yield differential voltages of appropriate amplitudes and polarities.

When an alternating-current tachometer generator is used, some means is usually applied to the output voltage to give it a constant amplitude, and then the signal is fed into a suitable frequency-discriminator circuit. Here the circuit constants have been adjusted to give no output when the input frequency has desired value.

As with the differential circuit described for use with the direct current tachometer, the discriminator converts deviations in frequency and, therefore, shaft speed, to direct voltages having proper polarities and amplitudes.

Power amplifier of an electrical governor may be all electronic, or it may include such devices as relays or magnetic amplifiers. In any event, its purpose is to convert a low-level signal representative of speed variations to a power level high enough to drive the actuator, usually a reversible electric motor. This electric motor is, incidentally, the part of an electrical governor that limits its response speed. The response of the speed sensing and amplifier circuits to a speed change is practically instantaneous, but the time required for the motor to translate the amplifier output into a throttle correction is relatively long.

Relative Advantages

This discussion of electrical governors is, of course, very general, and cannot possibly include the many variations that might be introduced. It indicates, however, that the use of electrical governors is quite feasible. They are not in more widespread use at the present time because they do not compare favorably, as far as cost and dependability of operation are concerned, with mechanical governors, which have been very highly developed.

Tachometer generators are, in general, more complex and expensive than ballhead assemblies, electronic amplifiers are more complex than hydraulic amplifiers, and certainly a hydraulic piston is a simpler actuator than an electric motor.

In addition, the mechanical system is less subject to malfunctioning than the electronic system, which is sensitive to vibration, moisture, and unpredictable component failure.

Despite these disadvantages, however, there has been an increase in the portion of the governor field occupied in recent years by electrical governors, especially in critical applications where extremely rapid response to speed changes and close regulation of speed are required.

The future of controllers utilizing the feedback or governor principle is almost limitless. There are very few instances of manual control that could not be improved by the application of a governor. THE END

Power Company Uses Mobile Cranes

Mobile cranes are making construction, operation and maintenance work at the Delaware Power and Light Co cheaper, faster and easier by lifting everything from poles to pumps, steel, transformers

FIVE YEARS ago, the company — which furnishes power to customers in three states — had no mobile wheel-mounted cranes of any kind. Today, with three five-ton self-propelled cranes and one 12-ton mobile truck-mounted crane, the company almost daily finds additional cost-saving, time-saving and muscle-saving uses for the machines.

Six years ago, the company hired a 12-ton crane with an operator at an hourly rate of $12.50. Today, in spite of generally higher costs for practically everything, the company operates its own crane for less than $5.75 an hour, operator included.

Cranes in Company-Wide Service

The mobile cranes play an active part in practically every phase of the company's operations. At the Wilmington headquarters of the Transmission and Distribution Department, the mobile cranes are handling poles, cable reels, transformers, switch gear and other delicate but heavy electrical equipment.

Frequently, a crane is driven under its own power to the Edgemore power station, on the northern outskirts of Wilmington, where it is used to handle power house equipment in maintenance and repair operations.

At Delaware City, where the company built and operates a 50,000-kw electric power station and a 1,500,000-lb-per-hr steam generating plant, another crane handles materials for the power station's operation. It also removes snow, and even humps railway cars carrying salt for the water treatment plant.

At a new power station being built at Indian River in southern Delaware, a third mobile crane is being used in construction work. After the station is in operation, the crane will remain to do maintenance, and materials-handling work.

(Each crane is an Austin-Western, installed on a self-propelled chassis equipped with front and rear end power steering, four-wheel drive, six-speed transmission and a torque converter.)

Fig. 1. Mobile crane handles transformers in and out of storage at Wilmington

Maintenance Work Simplified

The crane stationed at the Wilmington headquarters of the Transmission and Distribution Department unloads incoming transmission poles from freight cars, stacks them on storage piles and removes them from storage and places them on dinky trailers for installation crews.

The crane also places transformers and switches in storage — frequently by reaching over other stored equipment — and removes them from storage outdoors, carries them directly into repair shops and spots them in the exact position needed for inspection and repair.

During a recent program of modernization and expansion of substation transformer equipment, the crane handled structural steel at the job site, and, with the 35-ft telescoping boom extended and partially raised, lifted and placed in installation positions a large number of switches, including some 69,000-v air-break switches that weigh more than a ton apiece.

On several occasions, the mobile crane has raised a linesman into position 18 to 20 ft above the ground to make flying taps on dead power lines.

Pole-Setting Experiments

Several times the crane has installed poles in the field. Experiments are now under way to broaden this application. The company expects the unit to be more efficient in setting a large number of consecutive poles than the line truck's A-frame and hoisting gear now used.

At the Delaware City power station, one mobile crane is the only piece of materials-handling equipment on hand, except for an 80-ton overhead crane in the main generator bay. The mobile unit has done such jobs as hoisting man-hole covers to speed a check on a faulty cable, removing pumps from inside a full tank of sulphuric acid, and shunting railroad cars carrying salt to an outdoor pit where salts for water treatment are stored.

The maintenance department at the station recently used the crane to remove and reinstall a number of 500-hp electric motors in the pulverizer bay. This bay is located at ground level. The low overhead clearance requirement of the crane permits it to be driven into the building for this type of maintenance and repair job.

Maintenance Foreman Ben Streaker recently devised an ingenious method of permitting the crane to carry structural steel rods up to 50 ft long. The rods were needed in rebuilding a boiler furnace located just outside the pulverizer bay.

As the boiler furnace is situated between several other furnaces and behind additional equipment installed outside the power house the rods had to be brought through a series of narrow passages.

Streaker solved the problem by tying the rods in bundles, lashing one end of each bundle to the front of the crane, and lifting the other end with the crane hook so that the rods were carried parallel to the boom. This system prevented the 50-ft rods from swinging and permitted them to be carried through passageways less than 15 ft wide.

Handles Sulphuric Acid Pumps

Not long ago, several pumps had to be removed for repair from a 15-ft deep tank of sulphuric acid. Ordinarily, a scaffold would have been built and a block and fall used to hoist out the pumps. There would then have remained the problem of removing the acid from the pumps without spraying anyone with the dangerous liquid. The crane was placed alongside the tank, and the boom located so that the hook was over the tank. The external couplings which hold the pumps in place were disconnected and the pumps were lifted out. While the acid-covered pumps were held at boom's length, the pumps were washed down with a hose until they were safe to handle. Without the crane they would have had to spend several days building a scaffold. With it, they did the whole job in several hours.

Delaware Power and Light has come to look upon mobile cranes as an integral piece of operating equipment in practically every department. So many uses are seen for the crane that the company has developed the feeling that around a public utility company there are more cost-saving jobs for mobile cranes than any company will have time to explore. THE END

To Cut Maintenance Costs

Fig. 2. Pole handling in storage yard is regular chore for crane. It permits three men to do work formerly done by six

Fig. 3. Pipe can be carried through narrow passages by lashing one end of pipe to front of machine and other to hook

Fig. 4. 500 hp motor lowered into position in pulverizer bay of Delaware City power station, with crane boom horizontal

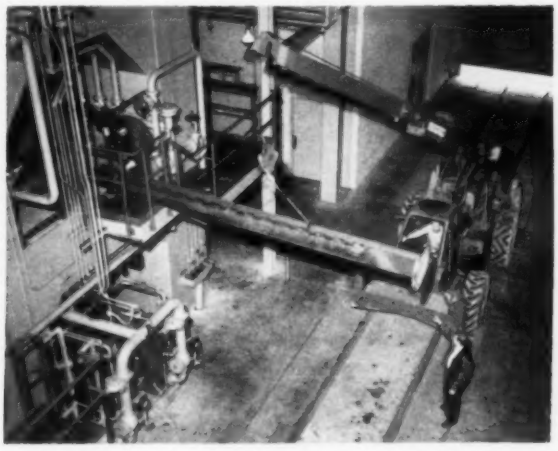


Fig. 5. Deaerator spray pipe quickly and easily installed in pulverizer bay of the power station by use of mobile crane

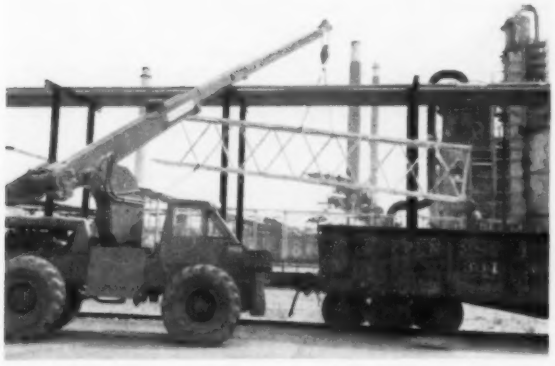


Fig. 6. Unloading cars is part-time job for crane. On occasion, crane is used to hump freight cars into final position

Fig. 7. Switchgear for Delaware City plant is moved from repair shop to substation in one operation by mobile crane

How to Buy Air Conditioning

Are you planning to buy air conditioning in the near future? If so, you'll profit by this practical, and straightforward analysis of the several systems to be considered. In this article, a prominent engineer discusses the pros and cons of air conditioning, with cost data

By W. L. FLEISHER, Jr.

BRIEF STUDIES of this type cannot possibly cover all phases of air conditioning in detail; nor special applications; nor equipment which has limited uses. Instead, they will give broad outlines of the types of systems in general use, and their relative merits; an evaluation of the major components comprising a system; a few rules-of-thumb for checking the required system capacity; and, some rough unit-prices to aid in budgeting and evaluating the economy of the design.

There are two major engineering classifications that determine the nature of an air conditioning system: 1, the method of producing cooling; and 2, the method of delivering the cooling to the conditioned area.

Cooling can be provided by well water, evaporative cooling or mechanical refrigeration. Since well water and evaporative cooling are limited to small areas with favorable climatic conditions, the majority of installations require mechanical refrigeration.

Compressor Selection

In the latter category there are three types of machines: reciprocating compressors, centrifugal compressors and absorption machines. Reciprocating compressors are the most economical in first cost for systems running up to about 250 tons. Beyond 250 tons centrifugal or absorption machines are as cheap as reciprocating, and have a much better life expectancy, less maintenance and higher reliability. Where these qualities are important, the centrifugal machine is the sound investment for the smaller installations, even though the cost may be 50 per cent higher than a reciprocating machine of the same capacity. Absorption machines have a higher first cost and installation cost, but deserve consideration where low-cost, low-pressure steam is available. Absorption machines are still comparatively new and experimental, and have operating and maintenance problems. Where steam is available at 125 psi minimum, and at reasonable cost, a turbine-driven centrifugal is hard to beat.

Here's a word about hermetic compressors, either reciprocating or centrifugal, that is worth remembering. In eliminating a shaft seal, the motor is put inside the machine, where it is pretty hard to get at if something goes wrong. This precludes on-the-job service, which is very important.

One other consideration in connection with refrigeration is the method of applying the cooling effect. It may be done directly, as in direct-expansion (DX) systems, in which the refrigerant is used to cool the air without any intermediate medium; or, in indirect systems in which a refrigerant is used to cool an intermediate medium, usually water, which is then used to cool air.

Centrifugal and absorption systems can employ only the indirect method; whereas reciprocating machines allow a choice of the two methods. Direct expansion systems should be limited to small equipment (up to approximately 50 tons) and a single air-handling unit, all equipment must be located close together, and there should be no requirements for close control of conditions.

About Air-handling Systems

The method of getting the cooling-effect to the conditioned area presents a more complicated problem. Ultimately all systems use air. The manner in which the air is moved and distributed is subject to many variations in equipment and duct design. The one exception to the all-air system is the employment of radiant cooling panels. Cooling panels have a very limited field of application and are not important in selecting an average system.

Air-handling systems fall into two categories: 1, low-pressure, low-velocity systems in which static pressures are within a range of $1\frac{1}{4}$ to 2 in., and velocities up to 1,800 fpm; 2, high-pressure systems with static pressure from 4 to 9 in., and velocities up to 4,000 fpm. The low-velocity systems are simple to install, easy to maintain, have good operating economy and an economical first cost. Their only drawback is that the ductwork can get rather large at times, and it may be hard to find a place to put it, particularly in the remodeling of existing buildings. The only excuse for using a high-velocity system is the need for smaller ducts. But a heavy price is paid for the reduction in duct size.

Ductwork Economics

High-pressure systems require four to six times the fan hp required in low-pressure systems. The additional hp shows up as heat in the conditioned air, adding about 20 per cent to the size of the refrigeration plant and its auxiliaries. Duct costs are two to three times that of a conventional system; to which must be added expensive sound traps, attenuators and static pressure controls. **The overall effect is to increase the cost per ton by 50 to 80 per cent.** If allowance is made for the 20 per cent increase in tonnage due to increased hp, **the total increased cost becomes 60 to 100 per cent.** Higher refrigeration capacity and fan hp result in a **50 per cent increase in annual operating costs.**

The above percentages may sound fantastic but an actual case will indicate what can happen. A two-story research laboratory was projected, designed with a 900 ton refrigeration plant, using a dual-duct, high-pressure distribution system, with 500 fan hp. The budget figure for the system was $1,600,000. Redesigned as a low-velocity system, the tonnage was reduced to 700, fan hp to 135, and the job purchased for $600,000. This is an extreme case; the final layout was not strictly comparable to the original, but it illustrates the contrast.

It can be seen that high-pressure systems should be avoided if first, and operating costs are important considerations. **Transporting cooling by air in ducts costs two to three times as much as moving it by water through pipes.** This means that systems employing air-handling should be centrally located in the area to be

About the Author

Walter L. Fleisher, Jr. is Chief Engineer of Rowland Tompkins and Son, Inc, Hawthorne, New York. He is the son of W. L. Fleisher, Sr., considered by most engineers as the "dean of air conditioning." Many years of experience in the design and construction of air conditioning systems provide the practical approach displayed in this article

cooled, and duct runs kept simple in layout and as short as possible. By locating a system centrally, it is possible to eliminate return duct systems entirely, or reduce their extent markedly. Obviously the type of building, and its use, will modify the type of system best suited, but inherently all buildings have many common problems.

Dual-duct systems have been getting a great deal of attention of late. In such systems, two parallel ducts are run, one carrying heated air, the other cooled air. The air is then mixed, either at a branch serving an area, or at an individual outlet. As each duct must be sized for about 75 per cent of the total air, the ductwork is increased by at least 50 per cent. Actually, the percentage is greater, as the ducts do not decrease in size in direct proportion to the quantity of air carried. Unless there is a need for individual control of many small areas, such a system has little to offer over a single-duct system, and does add appreciably to the cost of sheet metal, controls and operating problems.

Another variation of the above system is the multi-zone unit which operates on the same principle as the dual duct system, with the difference that the heated and cooled air are mixed at the unit, and individual ducts are run to the various areas. Again the duct work is increased, but not as much as in a dual duct system.

Both the dual-duct and the multi-zone system have the advantage of confining all piping systems to the equipment room area, but at the penalty of considerable additional cost. Same results can be obtained with a single-duct system, with a heating coil located in the branch duct leading to each control area. (See diagrams.)

As can be seen from the diagrams, each system accomplishes the same end result, but note the difference in duct work.

The emphasis on type of air handling system has been detailed for good reason; it is the major factor in determining the first, and the operating costs, of a system. **No matter what type of refrigeration plant is selected, the costs fall within a narrow range; whereas the type or air-handling can easily double the costs.**

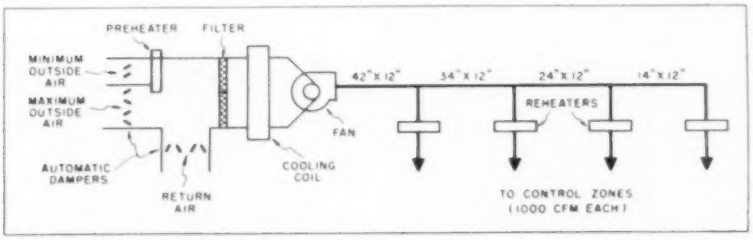


Fig. 1. Single-duct system, using reheaters in each controlled zone. This is the simplest of the air-handling layouts, and is cheapest to install and maintain

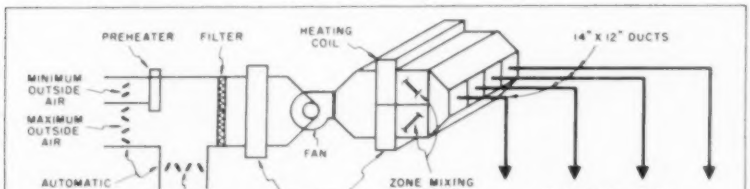


Fig. 2. Multi-zone unit system. This method conditions all incoming air, at one common point, then distributes it to the various zones in separate duct lines

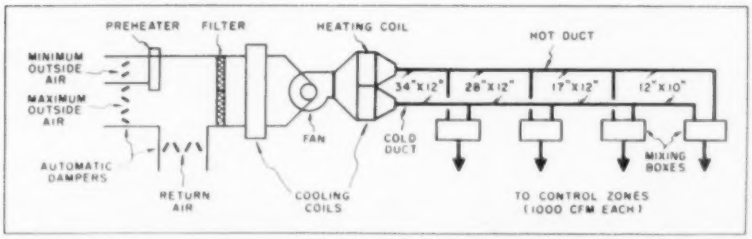


Fig. 3. Dual-duct system. Separate ducts carry both heated and cooled air to each zone of the building. Mixing boxes provide correct tempering in each zone

When starting the design or selection of a system always proceed with the simplest design, which is a low-velocity, single-duct, single-zone unit, located as centrally as possible. Single units larger than about 40,000 cfm become unwieldy. For large areas multiple units should be used. If possible, each unit should be identical in equipment and layout. In the event that equipment or duct space is limited, smaller systems can be used, but they should be limited as much as possible. Try to keep equipment grouped together, to keep down installation and maintenance costs. Areas requiring unusual conditions, such as environmental rooms, conference rooms, or those of high-heat concentration should be isolated and treated separately. The perimeter of a building, particularly when it is used for office space, requires heat for exterior walls and windows. It is desirable to combine the heating and cooling functions in a single system. This can be done by the employment of small fan-coil units, placed under the windows. These will reduce the size of the central system, and also the duct runs.

Each building has peculiarities which require deviation from the basic system. This is especially so in the remodeling of existing buildings. Any variations should be carefully weighed in terms of additional cost.

Select Components Carefully

With the type of system and basic layout selected, consideration of the components is most important. If the air conditioning system is required to have a useful life of 10 years, there's no economy in selecting components that will last for 25. **No system should have a projected life of more than 25 years,** because natural deterioration, technological advances, and changing space-usage will make the system obsolete in that time, or less. **There is a great tendency to overdesign;** either because of little faith in the engineering, or lack of practical experience. A motor one size larger than necessary only results in low power-factor and low efficiency.

Duct work gains nothing by using sheet-metal heavier than the standards developed by the American Society of Heating and Air Conditioning Engineers. Fittings and branch take-offs should be simple in design, since only the longest run determines the static pressure required at the fan. All shorter runs will have surplus pressure which will have to be dissipated at the fittings and dampers. Avoid special materials unless a definitely corrosive atmosphere is present. Copper ducts cost two and one-half to three times more than galvanized steel, and stainless steel runs up to six times as much.

The insulation of duct work and piping is for the purpose of preventing condensation and excessive heat pick up. One inch of Fiberglas, or its equivalent, is adequate for normal ambient conditions. Any increase in

insulation thickness will show an insignificant gain in efficiency.

Automatic controls are an absolute necessity for a satisfactory air conditioning system. Avoid over-control and complexity The control system should be kept as simple as possible. (After a few years of operation, many control systems have had a large number of the controls disconnected because they were too difficult to maintain.)

The idea of individual control has been one of the major selling points for dual-duct and high-pressure induction systems. Individual control sounds attractive and would appear to be a way of eliminating complaints; however, there are several drawbacks that should be considered. Each unit of control adds considerably to the cost of the system, and adds another maintenance point. In a large office structure this may mean several thousand control units **at a cost of about $200 per unit.** Individual controls mean varying the temperature in adjacent areas, which leads to complaints from people moving from area to area, because of the differences in temperature. Finally, is individual control really available? Unless the system is designed with excess capacity, the control is only one way; that is, hotter in the summer, and colder in the winter.

Avoid Too Many Controls

The average system is designed to maintain 80 F at peak conditions in the summer. Since 80 F is the upper limit of comfort, there is no need to have control above this temperature; but, to allow the individual to have a temperature below 80 F requires additional system capacity which is not economic, nor customary to provide. In fact, the individual thermostat may become a "boomerang" when it is set to a condition that the system cannot supply, and the occupant of the area complains loudly that the system is not working properly, or that the thermostat is a "dummy." **Experience indicates that the most satisfactory system is one where the controls are hidden, and only the operating personnel can adjust them.**

Conversely, enough zones of control must be supplied to take care of areas with different loading, or exposed to variable outside conditions. The automatic control system's main function is to maintain uniform conditions over the entire area, without rapid temperature changes. **Uneven temperatures most often are due to poor layout of the distribution system, rather than inadequate controls.**

Piping systems have been in use for a long time and should present no problems, but even here there seems to be an unreasonable conservatism in many designers. Very often wrought iron, copper, or brass pipe is specified when black iron pipe (and a simple system of water treatment) will give better protection against corrosion. The ASME and ASTM codes for piping provide adequate safety factors, so why go to the next heavier pipe or valve, when the pressures do not warrant it. The use of reversed-return piping systems is theoretically correct, but adds 50 per cent or more to most piping runs. Since most of the pressure loss in the system is through the equipment, and not in the pipe mains, the difference in pressure available at the nearest and end branch is not significant. With very long mains, a balancing valve, or cock, makes adjustment simple.

Selection of the air-handling equipment poses the problem of whether to use factory package-units or field-assembled units. The factory unit has the advantages of lower first cost, compactness, single responsibility, coördinated design, and requires the minimum of skill for installation. It also has the disadvantages of difficulty of maintenance due to its compact design, it is comparatively inflexible in application, and after a few years it may be hard to get repair parts due to model changes.

The field-erected unit offers a wide range of selection in equipment components and arrangement, and lends itself to easier maintenance and repair. It requires more careful design and much greater care and skill in installation.

Generally the package-unit will be desirable in capacities up to 12,000 cfm, where the duty cycle is not continuous, the required life is not over 15 years, and operating conditions are not unusually severe. The package-unit is highly desirable, also, for temporary installations, or where there is constantly changing process layout. For all other conditions, the field-erected unit will give a more satisfactory installation.

How To Determine Loads

A few rules-of-thumb will aid in preliminary estimates of loads and in checking completed designs. Like all rules-of-thumb, these figures must be used with a good deal of discretion and the realization that they apply to the normal installation. Some rules:—

1. **Office Buildings**: 30 to 40 Btu per sq ft per hr. One story buildings (or for top floor) add 5 Btu to the above figures, for the roof load. These figures are based on 3 watts per sq ft for lights and office machines, one person to 80 sq ft, and 1½ changes per hr of outside air.

2. **Industrial Buildings**: 40 Btu per sq ft per hr base load, to which should be added 3.4 Btu per sq ft for each watt above 5. Also, if large amounts of exhaust are required, this will have to be made up with outside air, which adds 32 Btu per cfm.

3. **Laboratories**: 60 Btu per sq ft per hr; but this may go to a high of 120 Btu per sq ft, depending on the ratio of laboratories to office areas, and the type of laboratory.

4. **Cafeterias and Auditoriums**: 10 people per ton of refrigeration.

5. Overall circulation of air should not be below six changes per hr. Below this figure there is trouble with stratification, and a dead (or stuffy) feeling.

6. Outside air should be a minimum of 1¼ changes per hr, or 15 cfm per person, whichever is the greater. Poorly constructed buildings will go as high as two changes per hr. These air changes are based on maintaining a slight positive pressure within the building, so that there will be no infiltration.

7. Total air circulation should be between 300 and 400 cfm per ton.

Average Budget Estimating Costs

Having calculated the load, or having estimated it from the above approximations, it would be very useful to have an approximate cost of a proposed system, either for budget purposes, or to check bids. Unit costs depend on many factors, such as the type of system, the geographic location, the type of building, whether new construction or alteration, and the overall size of the installation. The unit prices given below are valid for the New York area, and for a very straightforward, low-pressure system, designed on the principles enumerated above:

a. Office Buildings: $1000 to $1300 per ton
b. Industrial Buildings: $800 to $1000 per ton
c. Laboratory Buildings: $1200 to $1500 per ton

Building trades wages are about $5.50 per hr, including fringe benefits, taxes, and insurance. Labor averages about ⅓ the total field costs. A rough correction of the above figures can be made if your local area wage rates are applied.

Air conditioning is a comparatively new engineering field, but there is nothing mysterious about it. It is based on the same basic laws of physics as the other phases of heat and power engineering.

Summary

1. Two phases in air conditioning: Producing the cooling effect, and delivering it.

2. Cooling is obtained from well water, evaporative cooling, and mechanical refrigeration.

3. Three types of refrigeration machines: reciprocating compressors, centrifugal compressors, and absorption machines.

4. Use reciprocals up to 250 tons; centrifugals and absorption units above that load.

5. Dual-duct systems are too expensive for general application, unless there is a need for individual control of many small areas.

6. Don't over-design; start with the simplest system, and use discretion in adding to it.

7. Keep controls to a minimum; they are expensive.

8. Uneven temperatures most often are due to poor layout of the distribution system, rather than inadequate controls. THE END

Vacuum Interrupter Switches Score In H-V Power Applications

Three years of successful testing in high-voltage field operations have shown vacuum switches have long life and reliability in long line and load dropping, and in large capacitor bank switching

By H. H. SCHWAGER*

MORE THAN THREE years ago the author's company began high-voltage tests using vacuum switches to interrupt the charging current of long transmission lines. Interruption of the charging current of 115-kv and 230-kv circuits indicated the way for the design of interrupter switches of unusual performance.

It was realized that these switches could switch large capacitor banks and drop line and load currents more efficiently than is done by present day circuit breakers. In addition, at least at higher voltages, the design could be produced at a fraction of the cost of a circuit breaker.

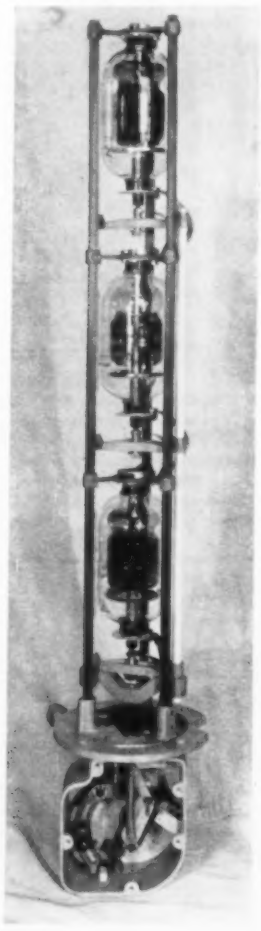


Fig. 2. (Left) Inside mechanism of interrupter switch removed from shell

Prior to its use in power systems the vacuum switch was commercially available only to the electronics industry. Several thousand permanently-sealed high-voltage vacuum switches had been commercially produced by the Jennings Radio Corp for radio-frequency, 60-cycle and d-c applications. These switches, like the one in Fig. 1, have given an outstanding service record during the past several years. Their voltage and interrupting rating was such that with slight modifications they could be ideally adapted for use in high voltage power systems.

Previous work along these lines had been done by Dr. Royal Sorensen of the California Institute of Technology. Dr. Sorensen proved that vacuum switches were well suited for power use. This work was done some 30 years ago, however, prior to the time that the technique of creating and maintaining high vacuums commercially was available. It took the development of the electronics industry to bring forth the techniques that have made possible the present commercial vacuum switch.

Unit shown in Fig. 1 is approximately eight in. long and has a diameter of four in. It consists essentially of an evacuated glass container inside which are located a fixed and a movable contact. The movable contact is operated from the outside through a metallic bellows which provides a vacuum-tight seal. The contacts are $\frac{1}{2}$ in. diam and made of tungsten. Total contact travel is 5/32 in.

This small gap will withstand a voltage in excess of 100-kv peak. When the contacts are opened under load, breakdown occurs immediately upon separation, and the 60-cycle current is carried to the end of the first half cycle where it is interrupted. After the interruption, the dielectric strength of the gap builds up at an enormous rate, making restrikes impossible. This is of great importance during the switching of capacitor banks since the absence of restrikes prevents harmful overvoltages otherwise present.

Fig. 1. Basic element of vacuum interrupter switch has surprising capacity

Vacuum switch unit being permanently sealed requires no mainte-

*Manager of Engineering, Schwager-Wood Corp

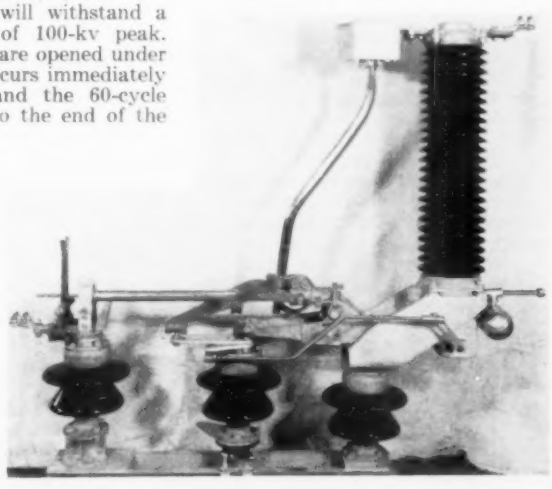


Fig. 3. Switch in closed position showing operating rods and contacts

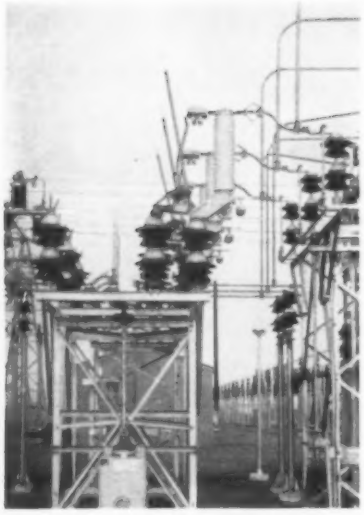


Fig. 4. 69-kv Bureau of Reclamation installation. Note the resistor at far left to limit closing-in overvoltages

nance and has a shelf life of over 30 years. It has an operating life of 10,000 interruptions at 50 amperes, 5000 interruptions at 250 amperes, 2000 interruptions at 600 amperes and 10 interruptions at 2000 amperes.

With this vacuum switch as the interrupter the Schwager-Wood Type IV vacuum interrupter switch was designed.

Assembly

Type IV vacuum interrupter switch consists of a conventional disconnecting switch of the rotating-insulator vertical-break type on whose hinge end is mounted a vacuum switch interrupter. The vacuum interrupter is a shunt device carrying current only for a short period of time prior to closing or at the beginning of opening.

When in the closed position, the interrupter is by-passed by a parallel current-carrying shunt blade. With this construction, the momentary and four-second high-current rating of the IV interrupter switch when in the closed position is equal to the corresponding ratings of the airbreak switch.

Fig. 3 shows an IV interrupter switch in the closed position. The vacuum switch interrupter assembly along with its activating mechanism is enclosed in the insulating weatherproof porcelain shell. Fig. 2 shows the interrupter removed from the switch. This interrupter uses 3 Jennings vacuum switches in series.

Operation

Operation of the switch is thus:

Initial 30-deg rotation of the disconnecting switch insulator stack opens the shunt blade, thereby allowing the vacuum interrupter to carry the full current. When the shunt blade reaches its maximum open position, the vacuum interrupter unit is tripped open at high speed, interrupting the circuit. The main blade as yet has not left the sparking horns on the front contact of the disconnecting switch.

Further rotation of the insulator stack opens the main blade of the switch, and prior to the fully open position, recloses the vacuum interrupter and also returns the shunt blade to a position alongside the main blade. The switch is now in the fully-open position. At the end of the opening stroke the vacuum interrupter is closed.

At the beginning of the closing stroke, both main blade and shunt blade are in the open position. The vacuum interrupter, however, is closed and remains closed during the entire closing stroke, so that the final circuit is not established inside the vacuum switch. The circuit is established when the main blade arcing horn approaches the stationary contact sparking horn. Closing of the circuit is initiated by a short spark between these horns.

Further closing of the airbreak switch then closes the shunt blade and establishes normal contact at the airbreak contact. In order to prevent welding during closing in, both stationary and movable sparking horns are made of nonwelding materials.

Field Experience

It was obvious that such a radically new development could not be generally introduced without long field experience on numerous installations. The results of field experience exceeded all expectations, justifying installations on a commercial scale. Accordingly, over 30 vacuum switches are installed as of this date for voltages ranging from 7.5-kv to 230-kv.

Although of the interrupter switch type, the installations are in locations where they replace circuit breakers. This required sturdy construction and reliability rather than emphasis on low cost.

In capacitor switching, as well as other switching, it is desirable to produce simultaneous interruption of all phases under all weather conditions. This is accomplished by the use of positive linkages in the operating mechanism, and the elimination of flying arms and large deflections in supporting members. It was particularly essential to support the interrupter unit on the two rear insulators, to facilitate the use of closing resistance to limit closing-in overvoltages.

At present, installations are in operation on 10 systems distributed over the United States, in both cold and warm climates. It is interesting to note that capacitor banks of the entire voltage range from 15-kv to 115-kv are in service, mainly for bank to bank switching.

In some cases the vacuum interrupter switch also provides fault protection of the bank. This is not generally the case since most often fault protection is provided by fuses or oil circuit breakers.

It is felt that the vacuum interrupter switch with its superior, restrike-free performance should be considered in all future installations of capacitor banks, replacing expensive oil circuit breakers. In addition, the vacuum switch is the only simple device now available to handle loads and charging currents on highest voltage systems economically and with absolute reliability. THE END

Typical installations of successfully-operating vacuum switches show wide range

SYSTEM	VOLTAGE	SWITCHING DUTY
California Electric Power Co	138-kv	100 Mile Line & Load Dropping
U. S. Bonneville Power Administration	115-kv	10,000 kva Capacitor Switching Single Bank Grounded
Texas Power and Light Co	138-kv	100 Mile Line & Load Dropping
Portland General Electric Co	15-kv	5400 kva Capacitor Bank to Bank Ungrounded
U. S. Bonneville Power Administration	23-kv	10,000 kva Capacitor Bank to Bank Ungrounded
American Gas & Electric Service Corp	34.5-kv	3600 kva Capacitor Bank to Bank Ungrounded
U. S. Bureau of Reclamation	69-kv	12,600 kva Capacitor Switching Bank to Bank Grounded
U. S. Bonneville Power Administration	115-kv	10,000 kva Capacitor Switching Bank to Bank Grounded
Utah Power & Light Company	46-kv	5,000 kva Capacitor Single Bank Grounded
Utah Power & Light Company	161-kv	Line and Load Drop
Potomac Edison Company	34.5-kv	10,000 kva Single Bank Grounded
Sacramento MUD	23-kv	5400 kva Capacitor Bank Ungrounded Parallel Bank
California Electric Power Co	34.5-kv	3300 kva Capacitor Bank Ungrounded 1125 amp Fault
California Electric Power Co	34.5-kv	7500 kva Capacitor Bank Ungrounded 2500 amp Fault
Arizona Public Service Co	230-kv	Line and Load Drop

Courtesy Hamilton (Ontario) Spectator

Know What Your Boiler Insurance Covers?

It's too late to find out afterwards. Boiler and machinery insurance is a specialized business, but the power engineer should have at least a working knowledge of the contract. Here's a helpful guide to the main considerations behind all that fine print in the contract

By ROBERT F. HAWKINS*

IT PAYS to know exactly what your insurance protection should be, before an accident occurs. First consideration is what limit-per-accident to carry for direct damage. This is a tough decision, and theoretically depends on the maximum possible loss. But nobody can or likes to say for sure precisely what damage an exploding boiler would do. The values of the plant and buildings, the contents and position of the pressure objects in the structure, together with their relation to neighboring buildings will, however, give a fair basis of estimation.

The insurance company man can help from his experience of accidents in similar plants, but it is unwise to skimp on the limit.

Insuring agreement is divided into five sections and, in the event of an accident, the limit would be paid in the following order:

1. Loss on the property of the insured, which includes not only the boilers, pressure vessels and equipment, but also the building and its contents.

2. If any portion of the limit remains after settlement of the insured's own property losses, expediting expenses, such as expressing of spares, overtime labor costs, etc, are paid up to $1000.

3. If the accident involved the property of others — say knocked down the wall of the man next door — it would be paid for out of any sum still remaining from settlement of 1 and 2, which would also go towards compensating for the other fellow's loss of use. If, as is usually the case, the insured also has a public liability policy, both insurances would be combined to contribute to the loss in proportion to their respective limits. This joint loss settlement holds good even though the liability and boiler insurance may be carried by different companies.

4. If anybody is hurt and there is still anything left out of the limit, it will go to the payment of the personal injuries sustained. This coverage is optional for a small additional premium and excludes payment under any Workmen's Compensation Acts. Again, if there is a personal injuries policy in force, the boiler policy will pay this time only after the limit of the liability policy has been used up.

5. Finally, the policy will pay the cost of any legal action in which the insured may be involved as a result of the accident, and this holds good even if all the limit has been exhausted in the property damage, expediting and personal injuries claims.

The general insuring agreement, however, is not specific enough to cover the multitude of equipment and possibilities involved in all industrial plants, and schedules are attached to provide the details.

Direct Damage Coverage

Boilers can be insured either for Limited or Broad coverage.

Limited coverage is the basic form and pays for damage caused by an explosion.

Broad coverage is an optional extension to the Limited form and in addition to protecting against an outright explosion, will also pay for losses caused by the burning, bulging or crushing of the object or its parts, or the cracking of cast metal parts sufficient to cause steam or water leakage. It costs more to have the Broad extension, but most of the losses are in this category, such as tube failures, collapsed furnaces, bulges and cracked sections, due to scale, sludge, failure of low water cutoffs and human error.

Furnace explosion coverage is another optional extension to the boiler protection and takes care of explosions caused by the ignition of inflammable gases in the combustion space or gas passages only, as distinct from an explosion caused by steam or water pressure. Accidents of this type are those commonly known in the trade as "blow-backs," and are the result of such causes as oil burner start-up failures and neglecting to purge the furnace with air before flashing up. This coverage costs extra, depending on the type of fuel used, but as it is also included in many fire insurance policies it should be checked to avoid paying twice for the same protection.

Unfired pressure vessels coverage takes in hot water and air tanks, retorts, cookers, heater chests, rolls, kettles and almost any other such object, and protects against bursting, bulging, collapsing or the cracking of cast metal.

Machinery coverage on compressors, steam, gas and water turbines, electric motors, transformers, switchboards, pumps, engines and flywheels can be added by attaching their particular schedule to the policy.

Indirect Damage Coverage

Use and occupancy insurance: When a boiler explodes, the cost of repairs to the equipment, buildings and contents is often small compared with the loss of profits while the plant is out of action. This can be very serious. Use and Occupancy coverage is designed to pay for the loss of profits, and also the fixed charges and expenses such as rent, light, heat, executive salaries, administration costs, etc., which the plant would have earned if an accident had not occurred. This coverage can be bought on a basis of a fixed amount each day for a stipulated number of days, or on an actual loss sustained basis with no daily amount of indemnity specified.

Consequential damage insurance: This form of coverage gives protection against damage which results from the lack of light, heat or refrigeration, etc, as a consequence of an accident to an insured object, and is of particular value in cold storage warehouses, large greenhouses and frozen food industries where a failure would result in big spoilage losses.

Inspection Service

Insurance companies maintain an inspection service to protect their interests and also to provide an engineering service to their policyholders.

In most States of the U. S. and several Provinces in Canada the local government certifies the insurance company boiler inspectors and accepts their reports in place of making their own inspections. In turn, the companies assist the policyholders to keep informed of and comply with the codes and regulations, and the comparatively small number of accidents in relation to the number of objects operating bears out the value of this service. THE END

*Guardian Insurance Co of Canada

Vapor Phase Cooling Systems Turn Waste Heat to Useful Steam

By preventing condensation of combustion products within engine passages, the use of cheap fuels is made practicable, lube oil requirements are lowered, and engine wear is decreased remarkably. But these are only part of the advantages of this ingenious plan

POWER ENGINEERS for many years have known the advantages of cooling internal combustion engines at temperatures somewhat higher than those conventionally used. That cooling systems operating at 212 F or higher have not been more widely used is difficult to explain, particularly in connection with stationary and marine equipment.

During the period immediately preceding World War II, and in the subsequent years, cooling at these higher temperatures has become somewhat more widespread. The results which have been achieved have more than justified the adoption of the method.

Important Advantages

Experience has shown that a number of important advantages accrue to engines cooled by water and steam at the boiling point. Perhaps the most important is the increase in engine life brought about by operation at temperatures in excess of the condensation point of the exhaust gases. This eliminates condensation of the products of combustion within the engine's passages, and subsequent acid formation.

Remarkable decrease is noted in the rate of cylinder wear, and in the formation of sludge in the lubricating oil, both attributable to the elimination of this condensation.

Conversely, it has proved possible because of lack of condensation to burn much less expensive fuels, high in sulfur content, bringing about substantial savings, as described below.

Other advantages include a uniform coolant temperature at all speeds and loads, and a faster warm-up period. Thermal circulation is used in many cases, eliminating the need for pumps. In recent installations, steam from the water jacket has been used to run a steam turbine, which drives a fan, cooling the lube oil and condensing the steam which is then recycled.

Other interesting applications of the steam generated by waste heat include building heating, air conditioning, and numerous process applications. Steam pressures commonly used vary from 0 to 25 psig.

In other installations the steam has been used for refrigeration, for the distillation of sea water, and in the treatment of sewage sludge and crude oil.

Vapor Phase is the registered trade mark which Engineering Controls, Inc, the maker, uses to identify their heat recovery system. Since making their initial installations on oil-well pumping engines in 1939, this company has engineered a great many stationary and marine cooling systems. Diesel, gasoline and gas engines of all sizes have been among the applications.

How It Works

Figure 1 illustrates the working of the basic scheme used in all Vapor Phase cooling systems. To begin operation, the system is filled with water to the operating level, approximately half way up in the Vapor Phase unit. Anti-freeze should of course be used where appropriate.

Water in the engine comes quickly to a boil after the engine is started, and thermal circulation begins. Wet steam rises from the engine through the section of the loop leading to the Vapor Phase unit. Although most heat is removed as latent heat of evaporation, a relatively small amount is removed as sensible heat. This amount necessarily remains quite unimportant, however, for there is no intentional cooling in the primary loop, and the temperature of the inlet water is lowered only by radiation.

Hot water and steam enter the unit through a tangential inlet, and swirl around the inside of the vessel with a continuous centrifugal force. This action separates the steam from the water and any foreign matter which might be present. The last settles in the baffled mud drum, from whence it is drawn off as necessary.

Secondary Loop

Steam then rises from the vessel through a steam separator, and enters the secondary loop, where it serves whatever useful purpose or purposes for which the system has been designed. It is returned to the system as condensate, and enters the primary loop in the manner illustrated. It is picked up by the steam and water mixture, and put directly into the Vapor Phase unit.

Make-up to the system is supplied automatically through the liquid

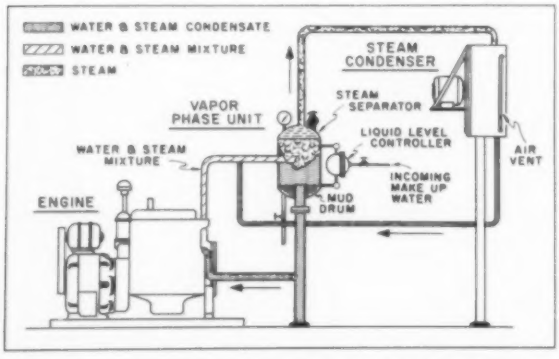


Fig. 1. Basic Vapor Phase cycle, in which internal combustion engines are cooled by evaporation of the cooling water

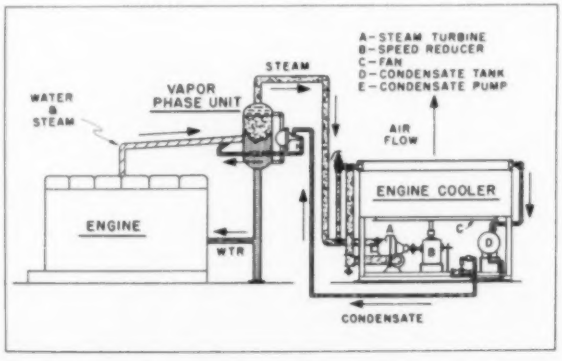


Fig. 2. Vapor Phase cooling cycle in which energy in waste heat is used to operate steam turbine driving a cooling fan

level controller. Appropriate pressure gauges, vents and safety valves are installed on the pressure vessel.

A low-water-level switch is mounted on the Vapor Phase unit, which will shut down the engine in the event the amount of coolant should become insufficient to protect it from overheating. A sight glass is also provided.

Variations

One method of using the waste heat of an engine to operate a highly-efficient cooling system for both coolant and lube oil is illustrated in Fig. 2. Here the steam from the Vapor Phase unit is used to operate a low-pressure steam turbine, which in turn is the motive power for a cooling fan, as well as a small condensate pump.

Operation of this unit, when properly engineered, is completely automatic. As the engine is started and steam begins to be produced, the turbine starts to turn the fan slowly. As the engine load is increased the volume of steam likewise rises, and the speed of the fan becomes greater.

Maximum speed and torque of the turbine is reached at rated engine load. Steam pressure rises to its preset maximum, and any excess bypasses through a relief valve directly into the condenser.

Another important and attractive point is that, in addition to varying with load, the amount of cooling air varies directly with the ambient air temperature. This is because more steam will be produced as less heat is lost by radiation, and the fan speed will be increased.

Relieved of the parasitic withdrawal of power for fan and pump operation, the output of a given engine will be approximately 10 per cent greater for a given fuel consumption. With large engines this becomes a major consideration, and the Vapor Phase system is quick to pay for itself.

Experience has proved that the most modern equipment, including a 3000 rpm steam turbine, does a complete cooling job for the largest engines, which require cooling for lube oil, gear oil, and, in the case of engine-driven compressors, for the compressor cylinders.

Fuel Savings

By maintaining minimum gas temperatures in the cylinders above 194 F, which is the dew point below which condensation may occur and acids be formed, the Vapor Phase system makes possible the use of untreated sewage gas and other fuels containing H_2S. Low cost residual fuel oils containing sulfur may also be used.

An excellent example of a highly-successful system using cheap, heavy, high-sulfur-content fuel oil is shown in Fig. 3. This scheme was adopted at the remote Bonneville Potash Plant on the Great Salt Flats of Utah, when, in 1949, a new 489-hp Worthington Diesel, with the illustrated system, was installed.

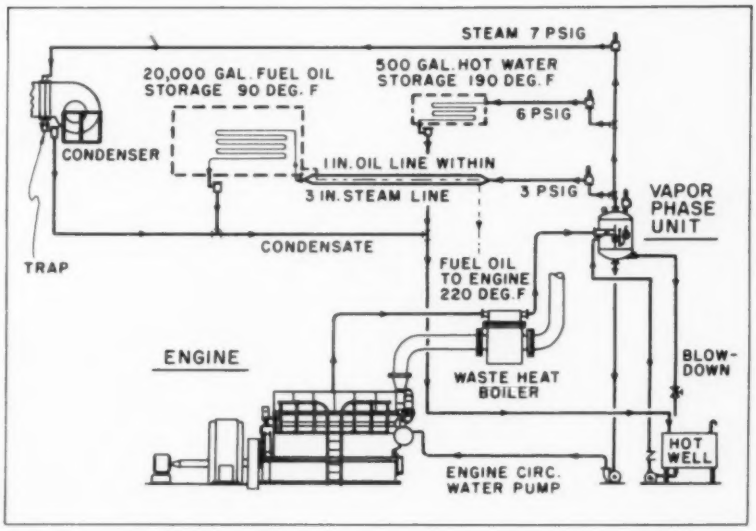


Fig. 3. Typical system for the use of Vapor Phase cooling to produce steam at various pressures for a number of purposes, as well as space heating, not shown

In addition to providing steam for the various purposes shown, and for considerable space heating, Vapor Phase cooling made it possible to cut the normal engine fuel bill in approximately half. Average electrical production is 14.25 kwh per gal. of the low-quality oil.

Lube oil consumption averages three gal. per 24 hr, or 4320 sea-level hp-hr per gal. So free is the lube oil from contamination that changes are made each 3000 hr instead of at the customary 500 hr periods.

Since the original installation, power production facilities have been tripled by the addition of a 1381-hp ALCO Diesel, also equipped with Vapor Phase cooling. This system likewise produces steam, which is utilized in new plant expansions.

Engineering

State of the art of Vapor Phase cooling did not rise to its present highly-efficient level without considerable engineering acumen, know-how, and experimentation. The achievement of the necessary balance of flow through all parts of the water jacket, with only natural thermal circulation, requires a well-designed conformation. Further, the right number of inlets and outlets of the proper size must be located exactly where the right flow will be maintained at various loads.

Since the steam rising from the engine occupies more volume than water would, these lines must be larger than the conventional. On the other hand, the pipe sizes must be such that the inlet leg, full of water, is heavier than the outlet leg, so that proper circulation will not be restricted.

Numbers of tests have been run with thermocouples taking temperatures in various parts of the water and metal affected by the cooling operation. Very low temperature differences are apparent, particularly when the Vapor Phase unit and the inlet leg are well-insulated. Temperature differences of as little as 2 F across the engine have been thus attained.

Circulating and Recovery Rates

Amount of steam generated in an engine depends upon its size, type and load. A naturally-aspirated, four-cycle gas engine requiring 10,000 Btu input per bhp will produce about three lb of steam per bhp per hr. This means a flow of about 0.108 gpm of water per bhp.

(In order to cool the same engine in the liquid phase, 600 gpm of water per bhp would be required, assuming a 10 F temperature rise.)

Heat recoverable from the jackets of a modern gas engine-driven compressor is in the order of 2500 Btu per bhp per hr. From older-style gas compressor units as much as 3000 Btu per bhp per hr can be recovered.

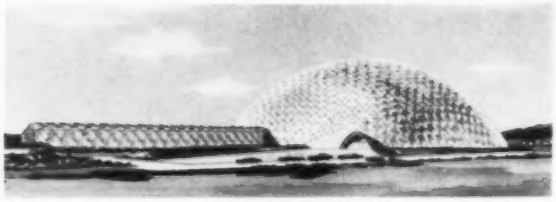
Where more heat is required, an additional 1500 Btu per bhp per hr can be recovered from the exhaust as steam at low pressure, or about 1000 Btu as steam at pressures up to 125 psig.

Quantity of heat recoverable from an engine depends to a great extent on its efficiency. Supercharged engines that consume 6500 Btu per bhp per hr will produce less than 1000 Btu per bhp per hr from the jackets.

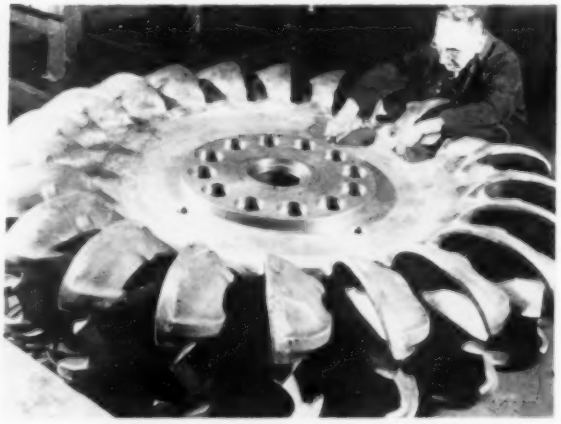
If you would like further information on this method of internal combustion engine cooling, write Vapor Phase at the bottom of the inquiry card in this issue, or request it directly from the Editor. THE END

POWER ENGINEERING'S

Rinsing a bottle for the Atlas ICBM. It's a 24-in. helium storage sphere which helps flow of propellant into combustion chambers of the missile. Titanium Metals makes the device of titanium to resist temperatures to —300 F

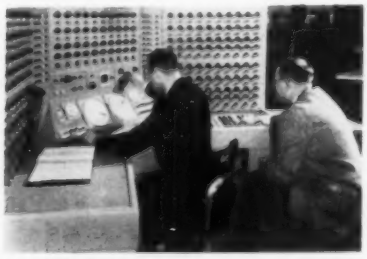


World's largest circular building without internal supports is this geodesic steel dome being built at Baton Rouge, La, for Union Tank Car Co. With 110,000 sq ft of floor area, its interior base is longer than a football field



Daisy of a bucket wheel is this cast steel unit being made by Allis-Chalmers for first impulse-type turbine ordered by U. S. Bureau of Reclamation. Buckets were cast integral with disk and approximate weight is 6000 lb. Unit will go into turbine at Green Spring, near Ashland, Ore.

Steel forms 41 ft high speed walls for 750,000-kw plant designed by Burns and Roe for Memphis, Tenn. Site is subject to flooding, requires these huge retaining walls. Forms permit complete sections to be poured in spans up to 36 ft

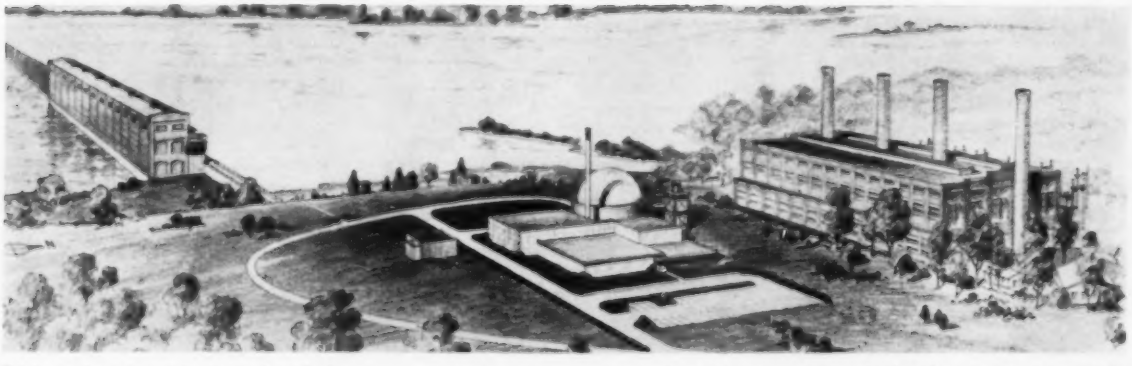


Brain for Turkey is this 3800-lb network computer which has been shipped to Turkish Central Power Commission by Electronic Contractors

NEWS REEL

Headin' West—six RM (repetitive manufacture) medium transformers leave G-E's plant at Rome, Ga, for use in Missouri. RM's are more compact than separate transformers and regulators, cut down on shipment time

Helicopter workhorse gently lowers section of a transmission tower into specially designed guide shoes which hold it in place until bolting. Southern California Edison is also using these versatile whirly-birds to set completely assembled power poles



Old and new, side by side. Nuclear power plant to be built at Parr Shoals on Broad River near Columbia, S. C., will be flanked by present hydroelectric plant at left, conventional steam plant (r). Stone & Webster designed it

1 Frequent conferences of supervisors include (l to r) Bill Curtiss, superintendent of steam and power, Bill Davidson, David McEwen, Victor Blender, Paul Keck. Supervisors get instruction in human relations, speaking, reporting

How We Train Men

Staff of 56 men is engaged in supplying the power needed by the varied operations of Pittsburgh Coke & Chemical Co. Carefully planned training for all sharpens skills and general efficiency

By JOHN S. DICKEY *

HIGH DEGREE of skill — and thus training — is necessary to fill the specific power needs of such diverse activities as coke, blast furnace, cement, activated carbon, by-product, protective coatings, and industrial chemical plants.

We are not particularly large, as power plants go, but from the diversification of our activities it is evident that our men must be prepared at all times to meet ever-changing operational requirements, and engage in planned preventive maintenance and emergency repair.

In order to maintain a high degree of efficiency in power plant operation we have established a three-phase training program for operators, a trades training program for maintenance men, and a diversified management training program for supervisory personnel.

Operator's Training

Phase I, threshold training: When an opening occurs at any hourly level, the job is open for bid in accordance with the Company-Union Agreement. Once the job has been awarded we begin Phase I of the training program.

During this period the new man has his first contact with the Steam and Power Division of our Central Plant Engineering Department. This portion of our program is divided into two areas — indoctrination and job training.

The indoctrination area consists first of making the new man feel at home, by introducing him to all of the men and supervisors and creating a friendly attitude. This attitude is, of course, essential for gaining the new man's full coöperation in the remainder of the training program. Also included in the indoctrination area is the subject of safety (the man has previously been trained in *general* plant safety procedures but now must be trained in *specific* procedures necessary for safe operation of the Steam and Power Division).

New man indoctrination also consists of organization training. It is explained to him where he is in the line organization (relative to Steam and Power), and the structures and requirements of succeeding jobs in the line of progression are also outlined to him. This indoctrination is conducted by supervisory personnel.

The job training area of Phase I consists first of providing the new man with a written description of the job, and secondly of placing him with the man he will shortly replace. The incumbent employee shows him as much of the actual job as he can in this short period of two weeks. In addition, the old employee and the immediate supervisor explain certain functions of the job that may not occur during the period of threshold training.

In the early stages of on-the-job training the new man observes the operation. In the latter stages he per-

* Supervisor, Training Dept, Pittsburgh Coke & Chemical Co

forms the work while the experienced employee observes and corrects him. While in this phase of training, the new employee receives the regular rate of the job.

One of the most important functions of the supervisor during this and succeeding phases is to explain, where possible, the "why" of the work, not just the "how."

Phase II, on-the-job training: When the older employee is released from the job, the new man assumes the full duties under *close* supervision. His fellow workers play a large part in helping him through the early period. As he gains confidence and begins to perform his job adequately, supervision is relaxed to allow individual discretion in many areas of the job. Safety instruction is continued, although more of it is on a group basis at this stage. As each new function of the job is performed the supervisor is on hand to show "how" and explain "why."

Phase III, training for advancement: The third phase of the operator's training program is to provide him a knowledge of the next job in the line of progression. This is done only through voluntary participation of the employee. During periods of absence due to prolonged sickness or vacation the senior man next in line is moved up to fill the vacancy. During this time he works under close supervision, as in Phase II. While filling the temporary vacancy he is paid the rate for that job.

Training for Maintenance

Under the Company-Union Agreement, when a vacancy in the maintenance trades occurs, the senior helper of one of the established trades bidding the job is awarded the vacancy. The exact length of the maintenance personnel training program will vary with the particular trade involved. On the average, however, the program extends over a period of from 18 to 24 months.

The new man begins the training program as a beginner-learner at a rate two job classes higher than the helper rate. He occupies this position for a period of at least 1000 hours. At the end of this period he may begin a second 1000-hour period as a Beginner-Learner at a rate four job classes above the helper rate; or he may advance to Beginner at the same rate, depending upon the particular trade involved. If he does have a second period as Beginner-Learner he advances to Beginner at the end of the second 1000 hours.

During the Beginner-Learner period or periods, the trainee works with a Standard maintenance man, learning by helping and observing while on the job.

When the trainee is promoted to Beginner he starts an additional 1000 hours of on-the-job training and also undergoes formal academic instruction by the Training Department in mathematics, blueprint reading, and trade information. At the end of this period the trainee must take a written examination on his class work, and an on-the-job performance test supervised by his immediate superior. If he passes both examinations he is promoted to Intermediate, two job classes above Beginner. If he fails, he must remain a Beginner and work an additional 30 calendar days or 173 hours before requesting re-examination.

After passing the Intermediate examination, the trainee is required to undergo an additional 1000 hours of on-the-job instruction and Training Department class work. At the end of this period he is once again examined in the area of job performance and academic work. If he passes the examination he has completed formal training and is promoted to Standard at two job classes above Intermediate. If he fails, he must once again remain in the same training category for thirty days or 173 hours before requesting re-examination.

The on-the-job portion of the maintenance training program includes not only specific job information but also material on safety, or-

for an Industrial Power Plant

2 Threshold training for a new man includes both indoctrination and job instruction. Victor Blender demonstrates operation of equipment to new man Henry Schneeman

3 Maintenance training program takes a man through four levels of job performance. Here Victor Blender discusses bearings repair with Beginners Earl Koontz and Ted Zadrozney

ganization, and other matters pertinent to efficient operations.

Management Training

Pittsburgh Coke & Chemical has a planned comprehensive program for training Steam and Power Division supervisory personnel. This program includes formal instruction conferences in human relations, report writing, public speaking, and contract provisions. As a result of this program we feel we are helping our supervisors to establish good on-the-job rapport with subordinates; establish good communication practices (down the line as well as up the line); more readily conduct meetings and conferences of men or supervisors; and more adequately understand and administer the Company-Union Agreement.

Supplementary Training

Where it is believed to be essential to competent operation of the Steam and Power Division, Pittsburgh Coke & Chemical provides the full tuition cost of in-school or correspondence school courses for supervisory and hourly employees.

In cases where a supervisor or hourly man elects voluntarily to take a course or courses that will benefit him at some future time or for later promotion, the company provides tuition assistance for a portion of the cost as long as the course is applicable.

Frequent conferences are conducted by the Superintendent of Steam and Power with supervisory or non-supervisory employees. A goodly portion of these conferences is devoted to discussion of what has been done and what must be done. Always present is the explanation of "why," when it is possible to provide such an explanation. These conferences are also used for providing new information as it becomes available in the area of power plant operation. Finally, the conference is used as a sounding board for ideas (up and down the line) and attitudes.

The Superintendent of Steam and Power frequently uses the bulletin board as a training technique. This is a suitable source for providing information that does not need much oral clarification. THE END

H-T Bolting: New Standards for Screw Threads

By PAUL G. SCHULZ *

IN THE PAST, problems of bolting on high-temperature service in steam power plants, oil refineries and many other installations, made it apparent that materials of greater elastic strength and creep resistance were necessary. It also became apparent that special consideration must be given to the threading.

The current ASTM specifications, ASTM A-193 and A-194 among others, are a result of continued evaluation of engineering advancements in the field of materials. Threading of high-temperature bolting has received attention similar to that given to materials.

Recognizing the need for an American standard, the American Standards Association appointed a subcommittee on screw threads for high-temperature bolting in November 1941. Work was done in correlating the various company standards. Some progress had been made when the War Production Board requested the Association to apply the war standards procedure to expedite the work.

Bolting complying with the War Standard dimensions enjoyed widespread application in the high-temperature field. The benefits derived influenced its use in other fields. In time, high-temperature threading became almost synonymous with alloy steel bolting. This knowledge prompted the desire to place the standard on a more permanent basis.

As a result of committee activity, the American War Standard was canceled and replaced by American Standard B1.4-1945. There were few changes, the most significant being the designation of these high-temperature threads as Class 7.

During the same period of activity in high-temperature bolting the entire problem of screw threads was being considered in ASA Sectional Committee B1. In 1949 the committee reissued American Standard B1.1. Several new classes of threads, among them Class 2A for external threads and Class 2B for internal threads, were added. The allowances and tolerances set up for these new classes were very similar to those existing in American Standard B1.4.

The new program naturally raised some speculation as to the need for two sets of dimensions so closely related, namely, Class 7 and a combination of Class 2A and 2B. After a thorough survey of company experiences, Sub-committee 7 of Sectional Committee B1 recommended that American Standard B1.4 be discontinued, and that Class 2A and 2B threads as covered in American Standard B1.1-1949 be used. The entire Sectional Committee B1, realizing the wisdom of the recommendation and its resultant simplification of tools and gages, voted in favor of it.

The next issue of American Standard B1.1, which is now in Committee and whose publication is expected shortly, contains the following recommendations for high-strength, high-temperature bolting:

12-High-Temperature, High-Strength Applications — for these applications the coarse-thread series is recommended in sizes from $\frac{1}{4}$ to 1-in. and the 8 thread series (8N) in sizes over 1-in. Some high-temperature applications involving special physical characteristics or conditions may require modification of dimensions, and it is recommended that when such are necessary, they be applied to the external thread.

17-Classes 2A and 2B — Classes 2A for external threads and 2B for internal threads are the most commonly used thread standards for general applications, including production of bolts, screws, nuts and similar threaded fasteners.

The maximum diameters of Class 2A (external) uncoated threads are less than basic by the amount of the allowance. The allowance minimizes galling and seizing in high-cycle wrench assembly, or it can be used to accommodate plated finishes or other coating. However, for threads with additive finish, the maximum diameters of Class 2A may be exceeded by the amount of the allowance; i.e., the 2A maximum diameters apply to an unplated part or to a part before plating whereas the basic diameters (the 2A maximum diameter plus allowance) apply to a part after plating. The minimum diameters of Class 2B (internal) threads, whether or not plated or coated, are basic, affording no allowance or clearance in assembly at maximum metal limits.

Certain applications require an allowance to permit application of the proper lubricant when making up the assembly, particularly with pressure vessels and steel pipe flanges, fittings, and valves for high-temperature, high-pressure service. For such applications Class 2A, which has an allowance, and Class 2B are recommended, replacing Class 7, which has now been discontinued as an American standard. In this application, when the thread is coated, the 2A allowance may not be consumed by such coating.

*From Crane Valve World. Mr. Schulz is Assistant Engineer of Standards, Crane Co.

Here are the facts about coal that matter, when you're . . .

Burning Coal in Pulverized Form

By U. B. YEAGER *

BURNING COAL in the pulverized form is the ideal way — within the limitations imposed upon it by size and cost requirements of the installations. For ease of adjustment, the flame approaches that of gas or oil. Under normal, or at least proper, operating conditions the response to changes in the load conditions is excellent, and practically instantaneous. Consequently, with the greater ease of air and coal adjustments, other things being equal, greater efficiencies can be attained.

Burning of coal in the pulverized form is governed by two broad considerations: one deals with the functions of combustion, the other with the preparation of the coal both at the mine and at the using plant by crushing and grinding into finely divided solids. In the first category there are a number of factors and these are the subject of this article. An article to follow will take up the physical preparation of a coal for a pulverized coal-fired application.

Moisture in the Coal

With the direct or unit system of firing more largely in use with the general type of industrial plant operation, as well as with most of the larger public utility units, the moisture in the coal is a very important item. Actually, each per cent of moisture offers more of a penalty than each per cent of ash. Not only does the moisture lessen the as-fired heat content of the coal by the amount of the moisture content but also carries away a certain amount of sensible heat, for it leaves the unit as superheated steam at a temperature of the flue gases.

Moisture appears in the coal essentially in two forms: surface and inherent. As the name implies, surface moisture appears in a free form on the surface of the particle of coal, while inherent moisture is finely divided throughout the individual particles and is in equilibrium with the moisture in the atmosphere under the conditions prevailing at the time and place of air drying. Quite often it seems that the effect of the moisture (surface, inherent, and that formed by the combustion process) is not given proper consideration.

Assume for instance that a 1-lb sample of the three following coals were taken at the point of use and that during the course of burning it was noted that the room temperature was 68 F and the flue gas temperature was 450 F. Typical proximate analyses of the samples are shown in Table I.

While the moisture content with the better coals, generally, is not enough to saturate the flue gases, still any great amount of moisture will add to any tendency for the water vapor to condense out of the flue gases in the air preheater, economizer, breeching or smoke stack during low load operations. The sulphur-bearing gases or carbon dioxide have greater opportunity to form sulphurous acid, sulphuric acid, or carbonic acid when or if the flue gases reach a temperature low enough to equal the dew points involved, all of which are corrosive to the steel and iron surfaces against which they might come into contact.

Table I. Typical analyses of coal samples

	Cedar Grove Seam	Ohio Pittsburgh #8	Lignite
Moisture (%)	4.0	6.0	36.0
Volatile Matter (%)	36.1	37.8	29.0
Fixed Carbon (%)	54.7	46.8	28.0
Ash (%)	5.2	9.4	7.0
Total	100.0	100.0	100.0
Sulphur (%)	.67	4.2	.65
Heat Value (Btu) (As R)	13,780	12,350	6600
Heat Value (Btu) (Dry)	14,354	13,138	10,313
Ash Softening Temperature (Deg F)	2750	2000	2050
Grindability (Hardgrove)	56	60	50
Ultimate Analyses (Dry Basis)			
Hydrogen	5.6%	5.4%	6.8%
Carbon	78.9	71.5	63.1
Oxygen	8.0	7.2	16.3
Nitrogen	1.4	1.5	1.9
Sulphur	0.7	4.4	1.0
Ash	5.4	10.0	10.9
Total	100.0	100.0	100.0
Losses per lb of fuel			
1. Due to moisture in coal (surface and inherent) (a) (lb)	.04	.06	.36
(b) (Btu)	574	788	3713
2. Due to combustion of hydrogen forming H_2O (a) (lb)	.480	.454	.389
3. Total moisture heated from room temperature to temperature of flue gas (1 plus 2) (a) (lb)	.520	.513	.749
4. Heat content of one pound of steam at 450 F and at slightly less than one atmospheric pressure = 1263 Btu less (68–32) = 1227 Btu (a)	(.520×1227)	(.513×1227)	(.749×1227)
(b) (Btu)	638	629	919
5. Total heat loss from moisture equals 1 (b) plus 4 (b) (a) (Btu)	1212	1417	4632
(b) (Per cent, based on dry heat value)	8.4	10.8	44.9

Note: 2a calculation as follows:

$$\frac{18.016 \times .056 \times (1.00 - .04)}{2.016} = .480$$

$$\frac{18.016 \times .054 \times (1.00 - .06)}{2.016} = .454$$

$$\frac{18.016 \times .068 \times (1.00 - .36)}{2.016} = .389$$

Most coals upon reaching a certain moisture content which appears to be largely a function of that particular coal, are characterized by a tendency of the particles to cling together rather tenaciously and also to cling to the various elements making up the conveying linkage from the point of unloading or from outside storage, through the bins, bunkers or silos and so on to the pulverizer and the furnace. By clinging especially to the pulverizing medium, the effect produced is similar to that of overloading of the mill. The mill's efficiency and rate of production or output are decreased and the relative amount of oversized particles is increased. This has an overall tendency to increase slag formation within the furnace.

It appears that under normal conditions 5 to 6 per cent of moisture (especially if the moisture is largely surface moisture, and the inherent moisture is 1 to 1.5 per cent) is a critical point or amount beyond which the capacities of the mills approach a condition of being overloaded because of poor handling properties of the coal. Generally, it has been found that the temperature of the air-coal mixture is limited to about 185 to 190 F, plus or minus 10 F, by reason of safety. It appears that in normal operations a temperature of 165 to 175 F is very good. However, as the weather gets colder or wetter, it has been found advisable to increase the temperatures of the air-coal mixture to that shown earlier. Loss of capacity due to insufficient drying will begin to be apparent as the moist air-coal temperature falls below approximately 160 to 165 F.

Generally, too, the primary air must be heated to a higher temperature for satisfactory results, and because of the effect of overloading, the primary air is increased in amount and velocity. Such action tends to increase the coarseness of the pulverized product. Amount and character of the oversized particles will carry beyond the normal ignition stage or zone to the walls, striking them in a semi-molten stage. It seems possible that the added moisture on the individual particles may form a vapor atmosphere about the particle preventing the necessary scrubbing action by the air for combustion.

This vapor atmosphere possibly

* Fuel Engineer, Island Creek Coal Sales Co, Huntington, W. Va.

builds up a partial pressure which might retard the distillation of the combustible gases to some extent. At the time of striking the walls, the particles contain a fairly high percentage of combustible material since their trajectory within the furnace has been within a reducing atmosphere. They have lost only a limited amount of the volatile content, and little or none of the fixed carbon has been gasified and consumed. This molten mass, dark, heavy and viscous, may gradually be oxidized, but there is a tendency for its atmosphere to remain as one largely reducing which, in turn, lowers the ash-softening temperature if the reaction is finally carried far enough.

Grindability of the Coal

The grindability of coals is essentially the relationship of the relative amounts of energy required to pulverize the coals under certain standard conditions Stated in different terms, grindability is that characteristic of a substance which determines the capacity of a given pulverizing mill to reduce the material to a standard fineness. While this is a term that is commonly used, it is generally agreed by all concerned that it does not adequately cover the descriptive functions and features that are really wanted. We have shown above, for example, how the effects of moisture can handicap the pulverizing capacity of a mill regardless of the grindability of the coal.

The term grindability, as it is broadly used, seems to imply certain characteristics which are not found in actual operation. For instance, grindability is supposed to indicate certain relative capacities or outputs of pulverizing mills with different coals. Yet in practice, a change in the surface moisture content of the coal of just 2 or 3 per cent can influence the mill output very greatly, producing far more of a change in output than would be represented by several points of change in the grindability index. Moreover, the same velocity of air current which will carry a small dense particle through a mill will carry a larger, less dense particle. Therefore, while the term has some value, it does not represent fully that which is sought.

It has been established that beyond a certain degree of fineness, the combustion process in the firing of pulverized coal is not helped materially. Objective is to reach the optimum fineness for a particular coal under the given conditions. In other words, the success of using pulverized coal is not so much a function or a requirement for an excessive amount of ultrafine coal but rather an operation characterized by a lack of excessive oversized coal (plus 60 mesh). An allowance of 2 to 3 per cent oversize (plus 60 mesh) adds much to the capacity of the pulverizing mill. A removal of the fines of the size wanted from the feed, as well as a removal of the same size from the mill after the desired degree of pulverization has been reached, adds much to the capacity of the mill and likewise brings a reduction in power costs.

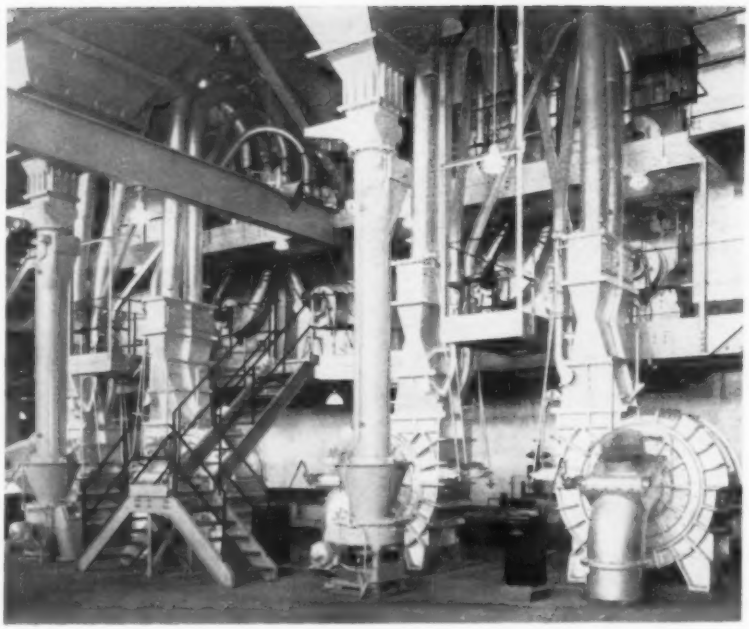


Fig. 1. Pulverized coal-fired application in a Midwest utility. Feeding and pulverizing installation in foreground and at lower level. Pulverized fuel is delivered to burners seen at 2nd and 3rd levels. Cutaway (right) explains system

Ash Content of the Coal

Ash as a noncombustible lowers the as-fired heat value of the coal in direct proportion to its amount. Ash appears in coal in two basic forms.

Extraneous ash is that portion of the ash which by one means or another, such as by hand picking or mechanically separating with air washing or water, can be physically separated from the coal. This ash may appear as bands or layers of rock, shale, iron pyrites, clay, etc, within the coal seam.

The mined coal may have other impurities as a result of the manner and means of mining. Inherent ash is chemically combined within the coal in such minute individual quantities as to prevent physical or chemical separation, as far as practical considerations are concerned. This ash is the result of the chemical components of the vegetation and of the decomposition of this along with possible mineral salts from the water within which the vegetation grew or was otherwise deposited.

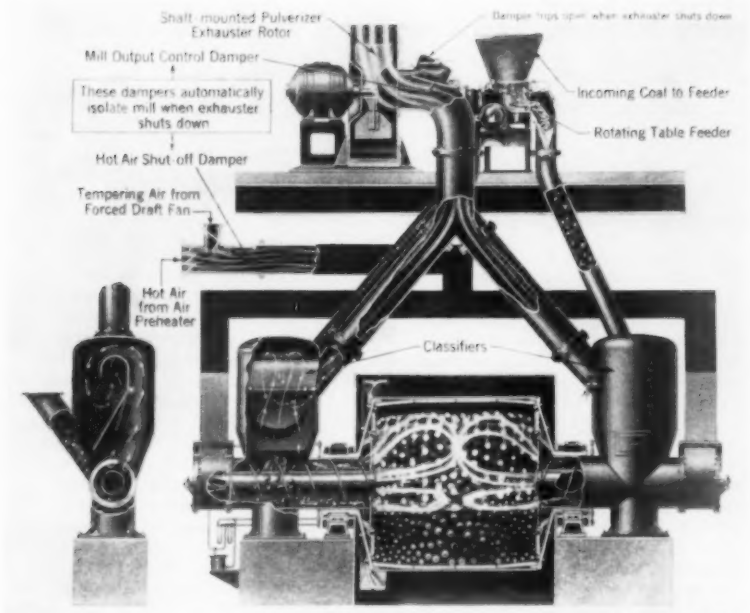
Constituents of the ash, therefore, by their character have a direct bearing upon the grindability of the coal and of the ash and slag which may be left behind as a solid residue within the furnace. Where both high and low volatile coals have been burned, pulverizer maintenance and overall operating costs are less with a cleaned high volatile coal having a grindability of about 55 than with a raw uncleaned low volatile coal having a grindability of plus 85. High ash is undesirable, for the flame velocity is reduced, ignition becomes less easy, and the flame less stable. Since the ash particles normally are harder to pulverize than the coal, the grinding costs are increased.

Paper titled Grindability of Coal From the Producer's Viewpoint, presented by R. M. Hardgrove at the Seventeenth Fuel Engineering Conference, Fuel Engineering Division, Appalachian Coals, Inc (January 11, 1937), states that maintenance costs brought about by the wear of grinding elements is often a more important variable than the cost of the power required to pulverize different coals.

Series of tests by H. F. Yancey, R. Geer, and J. D. Price, all with the Bureau of Mines, were reported in a paper, An Investigation of the Abrasiveness of Coal and its Associated Impurities, as noted in *Mining Engineer*, March, 1951. These tests were made with special abrasion apparatus with rotating arms and wearing blades. These blades were rotated at 1500 rpm for 12,000 revolutions with certain weighed samples of four kilograms each of various coals. These three interesting facts were brought out:

1. Most of the abrasion on the wearing blades was caused by the coarser particles of coal.

2. Impurities heavier than 1.6 or 1.8 specific gravity, in every instance, were much more abrasive than the clean coal.


Shaft-mounted Pulverizer Exhauster Rotor
Mill Output Control Damper
These dampers automatically isolate mill when exhauster shuts down
Hot Air Shut-off Damper
Tempering Air from Forced Draft Fan
Hot Air from Air Preheater
Damper trips open when exhauster shuts down
Incoming Coal to Feeder
Rotating Table Feeder
Classifiers

Foster Wheeler Corp

Fig. 2. Cutaway of a ball mill for pulverizing coal. Steel balls act as additional grinding medium during tumbling action. If coal has too high moisture content it will cling to pulverizer parts and create effect of overloading of mill

3. Abrasion loss of the wearing blades in milligrams for several coals varied from 12 for Cush Creek mine, Upper Kittanning bed, to 686 for Pennsylvania anthracite. The average abrasion lost for the nine coals tested was 163 mg. Sandstone showed an abrasion loss of 1210 milligrams and coke showed a loss of 2506 mg. Of 14 coals tested, half of which were divided into clean coal and the heavy impurity, the clean coal ranged in abrasiveness from about 10 to about 150 mg, while the heavy impurities which were separated from these coal samples varied from about 300 to 2847 mg.

In a somewhat related way these same facts are observed in the wear and erosion of various types of handling equipment in ordinary operation. In a new plant, the hammers of a pulverizing mill of that type were excessively worn after only about 2800 tons of pulverizing use. Examination showed that numerous samples of coal taken at the pulverizing mill contained 2 to 3 per cent of airborne and dozer-mixed sand. Storage coal had been placed on a sandy area without protection. After the growth of some suitable vegetation, and the use of oil and asphalt coverings of some areas, the sand problem was corrected. A later check showed other hammers still in use with no apparent wear after more than 8000 tons with the same coal but unhampered by the sand.

Heat Content of the Coal

Because of the many and varied factors brought out by the use of pulverized coal, the heat recovery more nearly approaches the comparative heat values indicated by the proximate analyses of similar coals. However, we have on record a number of performance tests where cleaned high volatile coals have given evaporation results on a par with or better than any of several coals which were analytically stronger.

Because the ignition and consumption of a high volatile coal is quicker or faster than a low volatile coal, the former does not have to be pulverized as finely as the latter in order to be fully consumed within the same length of flame or gas travel. Greater luminosity gained by the higher volatile flame brings about a greater available recovery of the radiant heat energy.

Particle Size

Size of the individual particles has a bearing on the combustion characteristics of the coal, but can bear only a direct relationship with respect to similar coals. High volatile coals are faster in igniting and faster in reacting than are low volatile coals. For that reason, a larger particle of the first can be consumed adequately by the combustion process in the same length of flame travel required of a smaller particle of the second. In other words, a low volatile coal must be finely pulverized for efficient combustion, with a minimum of ash pit loss.

From a practical standpoint, the aim is to reduce the coal to particle sizes that will produce the greatest efficiency in their consumption. The problem, therefore, has two other aspects: one is to produce a minimum of oversized particles, thus reducing the carbon loss in the ash residue and lessening the tendency to slag; the second is to produce a minimum of excessively fine particles which can offer as their chief contribution only the fact that excess power consumption was required and the effective capacity of the pulverizing mill was reduced by and for their attainment.

Initially, a reasonable average power consumption for pulverizing coal was about 20 to 28 kwh per ton of coal. With better drying of the coal, better quality of coal, both inherently and by preparation, and with improvements in the pulverizing mills, the power requirements have dropped largely to about 11 to 16 kwh per ton of coal consumed.

In some instances the figures of 11 to 12.5 kwh per ton of coal were given for coals having a grindability index (Hardgrove) of 100. Same load could be carried with a cleaned high volatile coal having a grindability index of 55 to 58 with a power consumption indicated at 14.5 to 16.5 kwh per ton. Therefore, unless the mill capacity has been badly overrated in the first place by human error, and unless the capacity of the mill is thus at a critical stage as to plant load, an excessive penalty against a clean high volatile coal as shown as against a coal of 90 to 100 grindability is definitely out of order.

The following are noted with respect to screen data:

Sieve Number	Sieve Opening	
	Inches	Microns
10	.0787	2000
20	.0331	840
40	.0165	420
60	.0098	250
100	.0059	149
200	.0029	74
325	.0017	44
400	.0015	37

In practice, screen analyses of the coal entering the furnace normally show 80 to 94 per cent of an average of about 88 per cent less than 100 mesh in size, and 68 to 76 per cent or about 72 per cent less than 200 mesh in size. There are, however, installations where the coal fired is plus 80 per cent less than 200 mesh. When speaking of oversized particles, the breaking point commonly is taken at 60 mesh, or particles plus 250 mu in diameter.

In many cases it is felt that satisfactory operating conditions require only about 0.8 to 1.0 per cent of such oversized particles. In some others as much as 2.5 to 3 per cent may be permitted. Worn pulverizer parts may cause an excessive amount of oversized particles. Points of inspection are the hammers of the hammer mill type and of the balls of the ball mills or ball race mills. Also, faulty classifying screens or rejectors may readily account for the excessively oversized coal. *continued on page 98*

With This New Heat-Recovery System, You Can Take A . . .

New Look At Continuous Blowdown

Substantial cash savings can result from the recovery of up to 95 per cent of the heat in boiler blowoff water. Package unit is one of several power packages to be described in POWER ENGINEERING

ONE OF THE MANY practices generally accepted as an aid to producing clean, dry steam, is continuous boiler blowdown. This process recognizes certain inherent characteristics of boiler water:

1. Solids are present in all boiler water.
2. Solids cannot be destroyed nor can the amount present be reduced by any known method of water treatment.
3. Solids, depending upon their chemical composition, will eventually form scale or corrode the boiler tubes, thus affecting the efficiency of the boiler.
4. Solids tend to concentrate near the steaming surface of a boiler and thus tend to prevent the release of clean steam.

A continuous blowdown system should be installed in such a way that water drawn from the boiler is removed near the steaming surface. This is the critical section of the boiler. It is important to relieve the tension or concentration at the surface to prevent such conditions as foaming or priming.

Thus, by removing water with the greatest concentration of solids and substituting make-up water with a lesser solids content, the average concentration of the water is reduced with the least amount of blowoff waste.

Blowdown Contains Dollars

In most boiler rooms, the blowdown water is drained directly to a sewer or passes through cooling tanks to reduce the temperature before putting it into the sewer system. In either case, the value of the heated water is wasted and in the latter, there is the additional expense of equipment, maintenance and floor space.

Modern boiler rooms do not waste this heat. With the proper equipment, it is possible to recover as much as 95 per cent of the heat in blowdown water. More than that, the cost of this equipment is so low that most boiler rooms can pay for the installation, through savings, in less than a year's time. After that, it is like money in the bank except that blowdown heat recovery systems pay dividends constantly and the bank only pays them once or perhaps twice a year!

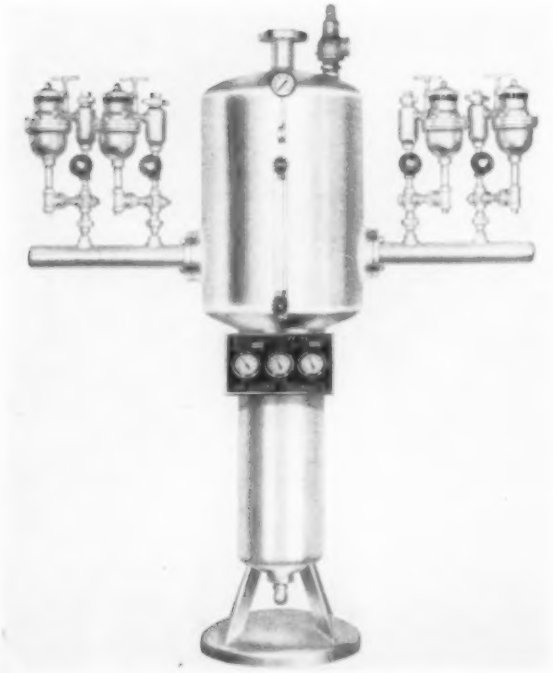
There have been cases where the heat recovery from blowdown has actually eliminated the necessity of adding another boiler due to the increase in output.

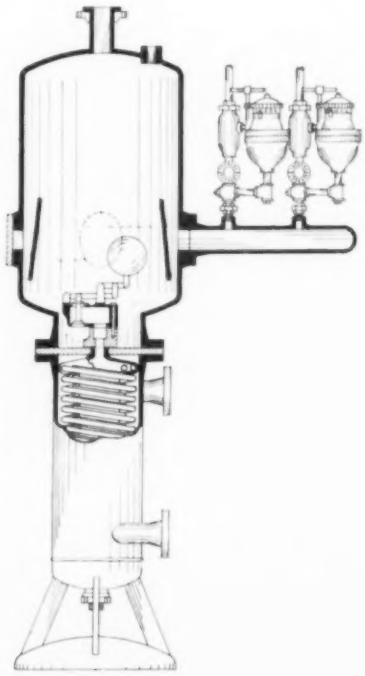
Let's take a theoretical example: Suppose that we have three boilers operating at 150 psi with a combined blowdown rate of 3000 lb per hr. Heat recovery equipment can save a minimum of 903,000 Btu per hr or 113 lb of coal each hr. In the course of a year's time, this could mean a saving of over 350 tons of coal!

What is Required

First of all, the system must be designed to eliminate any points that might trap mud. Eventually, this mud will clog the system which of course, makes the system ineffective and requires costly cleaning. While this mud is building up, there is a gradual lessening of efficiency and this costs valuable Btu.

It is often desirable for the system to be self-flushing rather than introduce some type of mechanical or electrically-controlled flushing arrangement, since this type of operation requires the introduction of out-





Figs. 1 and 2. Photograph and cutaway sketch of new heat recovery system. Operation is fully automatic and unit requires only minimum of maintenance

side water which in turn requires heating, piping, etc. Arranging the heat recovery system in a manner that provides gravity flow of the blowdown water accomplishes the purpose in the most economical manner.

Secondly, an efficient blowdown heat recovery system may employ the flash principle. Several major advantages are claimed for flashing blowdown water:

1. Fifty per cent or more of the heat is recoverable in the form of flash steam and this permits a wide range of flexibility in its use. Some of the uses are space heating, process work and the heating of fuel oil or make-up water. In addition, the condensate may be recovered, and by returning this water ultimately to the boiler, there is a reduction in the amount of internal chemical treatment necessary.

2. With the employment of a flash tank, the companion heat exchanger may be operated at low pressure. By the same token, the mean temperature between the blowdown water and the make-up water is greatly reduced and there is no stress on the equipment nor is there a tendency for scale to form on the cooling side of the exchanger. Temperature rise of the cooling medium will usually be no more than 20 F.

3. The heat exchanger can be designed so that only a single pass of the boiler water is necessary to transfer the heat. Therefore, the heat exchanger can be smaller than one necessary to transfer the total amount of Btu.

Additional Requirements

Third, the flash tank should be designed specifically for blowdown water in that it should have adequate surface area and ample retention time. Adequate surface area allows the flash steam to travel far enough to rid itself of solids and water before being released to the pipe lines. This promotes clean, dry steam. Ample retention time allows a greater amount of water to flash to steam and reduces the unflashed water temperature the maximum amount.

Fourth, the design of the heat exchanger should take into account the turbidity of blowdown and eliminate all pockets, corners or changes of flow that will accumulate solids.

What's Available

Until recently, blowdown systems were furnished strictly on a custom-made basis. This involved a great deal of the consulting engineer's time plus some rather involved construction work that had to be performed on the job site. All of these things added up to relatively-expensive systems. Also, in many quarters, it was generally regarded as nuisance work.

Gradually, some manufacturers offered lines of equipment for this purpose but these still involved engineering time and the building of scaffolds or cradles. This has been an improvement, but still is hardly in keeping with the modern trend packaged systems.

A New Package

Recently, a manufacturer introduced what is believed to be the first packaged heat recovery system designed specifically for use with continuous boiler blowdown. These units are shipped to the user completely assembled and it is only necessary to make a minimum number of pipe connections before the system is ready to operate.

Close-coupled design does away with scaffolds, cradles, etc, that were formerly needed to complete blowdown systems. It is estimated that approximately 70 per cent of the installation costs have been eliminated. Floor space requirements are held to a minimum, the largest system requiring an area less than three feet square. A cutaway sketch of the unit may be seen in Fig. 2.

Operation of the new system is very simple but highly efficient. Knowing the turbid characteristics of blowdown water, engineers have designed the units so that maintenance has virtually been eliminated. The principle of gravity flow is utilized throughout and once the blowdown water leaves the boiler, it travels by gravity at all times.

Flash tanks are of the vertical type and are baffled to create turbulence. This gives the tank additional surface area.

A new balanced-pressure float valve is designed to allow a continuous regulated stream of water through its valves rather than the conventional dumping common to ordinary float valves. This continuous stream of the right amount of water provides a "scrubbing" or flushing action in the coils of the heat exchanger column.

Operation

Heat exchanger coils never run dry and the heat exchange process is going on all the time. A hand hole in the rear of the flash tank makes access to the float valve relatively easy. All working parts of the float valve are constructed of stainless steel, including the float ball. Valve seats are the removable type.

Tangential connections are provided for the make-up water inlet and outlet in the heat exchange shell. This design creates a swirling action of the cooling medium and increases the heat-transfer efficiency.

There is visual indication of conditions in the system at all times. Part of the package is a gage panel showing temperatures of the cooling medium and the blowdown water.

Any number of boilers can be connected to the same heat-recovery system by the addition of another flow control unit per boiler.

Heat-recovery system is available in three maximum capacity ranges: 3000, 5000 and 7000 lb of blowdown water per hr. All of the pressure vessels are designed and built to comply with the requirements of the ASME Code.

For more information, write the Editor, or jot Blowdown on the return postcard which may be found elsewhere in this issue. THE END

Tabulation of practical heat recovery from continuous boiler blowdown with the boiler pressure at 150 psig. By adding together any two or more of these values it is possible to determine the savings for almost any volume of boiler blowoff

Total Blow-Off Lb per Hr	Lb of Water Flashed at 5 psig—14.6%	Btu Recovery per Hr from Flash Steam 1155-Btu per Lb	Specific Volume of Flash Cu Ft per Hr	Water Remaining after Flash Lb per Hr	Heat in Unflashed Water Temp 225 F	Recoverable Heat in Water with Cooling Medium at 60 F plus 10 F Transfer Loss	Total Heat Recovery from Boiler Blow-Off Btu per Hr	Savings in Terms of Coal Lb per Hr
1000	146	168,630	3066	854	192,150	132,370	301,000	37
1250	182	210,210	3822	1068	240,300	165,540	375,750	47
1500	219	252,945	4599	1281	288,225	198,555	451,500	56
1750	255	294,525	5355	1495	336,375	231,725	526,250	66
2000	292	337,262	6132	1708	384,300	264,740	602,000	75
2250	328	378,840	6888	1922	432,450	297,910	676,750	84
2500	365	421,575	7665	2135	480,375	330,925	752,500	94
2750	401	463,155	8421	2349	528,525	364,095	827,250	103
3000	438	505,890	9198	2562	576,450	397,110	903,000	113
3250	474	547,470	9954	2776	624,600	430,280	977,750	122
3500	511	590,205	10,731	2989	672,525	463,295	1,053,500	132
3750	547	631,785	11,487	3203	720,675	496,465	1,128,250	141
4000	584	674,520	12,264	3416	768,600	529,480	1,204,000	150
4250	620	716,100	13,020	3630	816,750	562,650	1,278,750	160
4500	657	758,835	13,797	3843	864,675	595,665	1,354,500	169
4750	693	800,415	14,553	4057	912,825	628,835	1,429,250	178
5000	730	843,150	15,330	4270	960,750	661,850	1,505,000	188

Figure Your Industrial Steam Costs Accurately

When you are supplying steam to industrial processes, you must pinpoint its cost, for charging against finished product. To do so, establish charge basis, check operation, meter the plant, maintain records, check on schedule. You can make your power house pay well

PRICING a manufactured article can be a matter of guesswork or science, depending on how long a manufacturer wants to stay in business. Realistic pricing begins with an accurate breakdown of production costs, among which steam and power are important items. They must be pinpointed so an appropriate charge can be made against the finished product. Also, to make a virtue out of a necessity, taking a square look at those costs may indicate the need for operational improvements to reduce costs, or suggest plant economies. Accurate instrumentation and recordkeeping are prerequisites for costing steam and power production. Here's the way to go about it, according to *News Notes* of Bituminous Coal Institute.

First Check Operation

Proper preliminary step is to make sure that steam production is not costing more than it should in the first place. An alert engineer, whether encouraged by management or not, recognizes the need to make his department an efficient, controlled productive unit; others never get past the day-to-day stage of keeping the pressure up and the boilers operating one way or another. Constant steam pressure must be maintained regardless of load conditions, but it should be done with optimum efficiency and that includes proper operation of stokers or other burners. Operational records should be kept, and regular checks made on all vital plant components.

Establish Basis of Charge

For the purpose of cost accounting, the boiler and power departments of a manufacturing plant must be regarded as separate units selling their products to the manufacturing sections. In plants where no power is generated and steam is used by the various process departments at the same pressure, unit steam cost may be based on 1000 lb of steam. Where power is generated in the plant, and process departments use extraction steam at various pressures, a generally applicable and widely used unit is a million Btu, sometimes expressed as 1000 lb of standard steam (where one pound of standard steam equals 970 or 1000 Btu). (Fuel too is often bought on the million Btu basis.)

With the pressure and temperature of steam automatically controlled, the following measurements are needed for the costing procedure.

Meter the Plant

1. Quantity of steam distributed to power and process.
2. Pressure and temperature of steam used by the various departments.
3. Quantity and temperature of condensate return from the departments.
4. Net power produced; that is, gross power produced minus auxiliary power used in boiler and power house.

Quantities of steam used by the process departments can be determined most economically with totalizing steam meters, which are less expensive than the steam recorders with pen charts normally used in boiler houses. The total quantity distributed to the plant may then be found by (a) totaling the quantities used by the process and power departments, and/or (b) making a percentage allowance for steam used in the boiler house for auxiliaries.

Quantities of condensate return and temperature may be measured. A more practical and economical method, however, is to make a periodic heat balance of the plant, determining percentages of condensate returned and average feedwater temperature. For example, if one department used steam at an enthalpy of 1200 Btu per lb and returns 50 per cent of its intake steam as condensate at 200 F to the boiler house, the departments should be charged with $1200 - (0.5 \times 140)$ or 1130 Btu per lb of steam used, taking the makeup water temperature of 60 F as the base.

Similarly, in a power department where all back-pressure steam is sent to process, only the net amount of heat used in that department is charged to power. Where there is some condensing power, the heat in the steam condensed must be charged to power, making allowance for heat in the condensate above 60 F, if any.

Maintain Cost Records

Records must be kept of all costs except those of steam and power used for auxiliaries by the plant power department. Cost items include fuel, labor, maintenance, water, chemicals, purchased power and such fixed costs as depreciation, insurance and taxes.

Cost of fuel is self-explanatory. In the average industrial plant there is no need to weigh the coal as it is used. Automatic weigh scales or weigh larries are costly and require maintenance; only large industrial and utility plants can economically justify this equipment. It is recommended that determination of fuel quantity used can be based on invoices for fuel purchases, with due allowance made for changes in fuel inventory. This method is accurate enough for the purpose.

Cost of labor should include only labor strictly chargeable to the boiler plant. For example, where a yard crew unloads coal cars on a part-time basis, only the man-hours directly chargeable to car unloading should be included. Allowance should also be made on a percentage basis for engineering supervision.

Computation of the cost of such items as maintenance, water and materials usually presents no difficulty. The percentage breakdown of fixed costs, however, depends on company policy and varies considerably according to the type of industry. The life of boilers and stokers may be taken at 20 to 30 years, buildings at 30 years, and electrical equipment at 15 years. In general, utility stations vary their depreciation rate between two and six per cent, with only a few items exceeding this range; many chemical plants, on the other hand, write off their equipment much faster. Fixed cost totals, including insurance, taxes, interest on borrowed money, and the like, probably range from 10 to 15 per cent for most industrial plants.

Check Costs on Schedule

Some large industrial plants find it economical to determine their unit steam cost and steam quantities every month. Others charge steam quantities monthly but adjust the unit steam cost only once or twice a year. The frequency of costing in a specific plant should be based on an individual decision. The main thing is that, with a reliable system of cost accounting, there is a good chance to make the boiler and power house an efficient and profitable operation. BCI is able and willing to help industrial plants start such a system or check on the value of existing systems in determining steam costs.

Editor's Note: In many organizations, the power engineer will have to work closely with the company's accounting department on some of the above points.

THE END

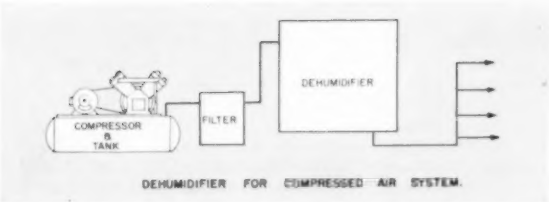


Fig. 1. Schematic diagram of equipment used in dehumidification of compressed air in the conventional industrial system

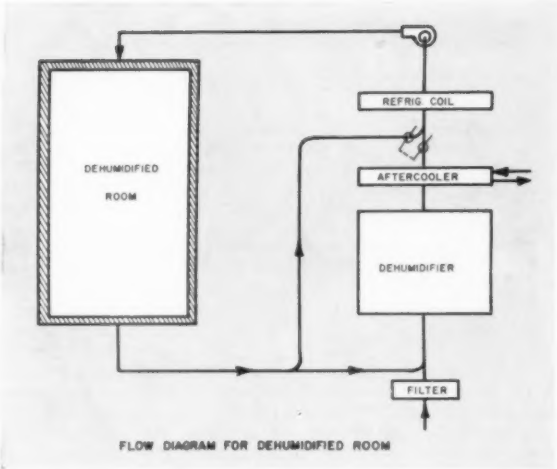


Fig. 2. Layout of equipment for dehumidifying a controlled-atmosphere area. In addition to this equipment, area must be properly sealed with a satisfactory vapor-barrier material

Water Vapor—Third Dimension In Atmosphere Control

Humidity control becomes more important in process industries today. Two factors are involved: dehumidification and prevention of water vapor penetration. Both are discussed by experts in this field

By E. R. QUEER and E. R. McLAUGHLIN *

WHEREVER air is used for process atmosphere or control the properties most likely to be controlled are temperature and or pressure. One or the other of these is likely to be a predominant factor and occasionally both must be controlled. In certain applications it is also necessary to control the water vapor mixed with the air to produce the desired results or to avoid undesirable consequences. This water vapor is relatively close to its saturation temperature and frequently may be cooled to its saturation temperature causing condensation. Oxygen and nitrogen and other components in the air represent gases at temperatures well above their saturation temperature and consequently there is little difficulty with their condensing. This difference can be utilized in removing water vapor from air.

Chilled coils will cause water vapor to condense and the water or frost on such coils represents water vapor removed from the air flowing over the surface. There is a practical limit to the dryness to be attained in this manner as there is a limit on the refrigeration and coil surface temperature. Alternate methods for air drying include absorption by the hydroscopic materials such as liquid sorbents (glycol or lithium chloride solutions), salts (calcium chloride) or adsorption by solid sorbents (activated alumina or silica gel). The drying equipment is designed to meet other requirements of volumes and pressures desired. Compressing the air-water vapor mixture and condensing the water vapor in an after cooler is another dehumidification process.

The cost of drying air is a variable depending on air pressure, degree of dryness desired, cost of energy for reactivating the desiccant and the efficiency of the dehumidifier. For general conditions and average dryness it requires 3400 Btu to remove a pound of water vapor. This is equivalent to 1 kwh per lb. Each pound of water removal will dry 2000 cu ft from summer conditions to moderate dryness. These are general terms to aid in visualizing approximate magnitudes of drying processes. Table I shows the cost of dehumidification with different fuels and fuel costs.

Dry air is a commodity to be conserved by practical methods consistent with the cost of drying. Maintaining a dry atmosphere in a permeable enclosure is comparable to trying to inflate a cotton sack. It can be done if there is an adequate air supply. Prudence indicates, however, that a less permeable bag would be easier to inflate. Here the simile ends for there is no assurance that a material impermeable to air is also impermeable to water vapor. If the enclosure is to be made water vapor resistant to reduce the flow of vapor, materials with proper permeability characteristics must be selected. Enclosures to be constructed can be erected with low permeability materials or a specific vapor barrier can be installed at the proper location within the wall. This location is not critical for enclosures not subjected to a temperature difference. The vapor barrier can be located on a basis of convenience or protection. On enclosures subjected to temperature differentials the vapor barrier should, as a general rule, be located on or near the warm surface. Many films and coatings are available for application to existing enclosures.

A dehumidified space should be operated much as any other conditioned space such as a refrigerator.

Table I. Fuel costs in dehumidification

COST OF DEHUMIDIFICATION

Cents per pound of water vapor removed (3400 Btu per lb)

	UNIT COST	CENTS PER POUND
Electric (Per kwh)	$0.0075	0.75
(3413 Btu per kwh)	0.0100	1.00
	0.0150	1.50
Gas (Per M Cu ft)	0.20	0.07
(1000 Btu per cu ft)	0.40	0.14
	0.60	0.21
	1.00	0.34
Oil (Per gallon)	0.10	0.31
(140,000 Btu per gal)	0.12	0.37
	0.15	0.46

*Consulting Engineers, State College, Pa.

Table II. Water removal capacities

DEHUMIDIFIED MATERIAL STORAGE	
A Volume of Material	B Cubic Feet Per Pound
1 To 10,000 Cubic Feet	1350
10,000 To 40,000 Cubic Feet	1500
Over 40,000 Cubic Feet	1650

(Note: Figures in Column B are given in cubic feet per pound of water removal capacity at 70 F and 35 percent.)

Openings must be kept to a minimum, with doors closed except when in use. Incoming materials should be in approximate equilibrium with the maintained air conditions. Excessive moisture in the materials can represent quite a water vapor load on the dehumidifier. The use of water and steam within the space must be an absolute minimum or provision should be made for its removal. Dehumidifiers are expensive substitutes for steam vents or bilge pumps.

The design of a dehumidification system requires consideration of the nature of the load and the conditions under which the water vapor is to be removed. There are many situations which are virtually standard because of the frequency with which they occur. For such applications there is standard equipment readily available for installation with a minimum of design or modification. Systems involving large air quantities, extreme dryness or extreme pressure or temperature will require a design analysis and perhaps special construction to assure the features desired.

Dehumidification requirements will vary with the usage and enclosure of the dehumidified space. For suitable enclosures for dehumidified storage wherein the infiltration or air leakage is less than 6 air changes per 24 hours under a static pressure differential of 0.25-in. water gage, one lb of water vapor removal capacity per 24 hours at air conditions of 70 F and 35 per cent RH will serve to maintain approximately 1500 cu ft of space. Spaces less than 10,000 cu ft should be calculated at 1350 cu ft per lb capacity while spaces over 40,000 cu ft should be served by a rated capacity of one lb per 24 hour for each 1650 cu ft.

Process rooms and other spaces subject to considerable activity and additional vapor loads will require more dehumidification capacity. Total dehumidification loads must be calculated from known design conditions and equipment selected accordingly. Manufacturers will give assistance in selecting equipment to meet the design conditions.

A judicious selection of load factors will avoid serious mismatching of equipment and load. Design factors must not be compounded to require an excessive capacity, just as vapor loads must not be overlooked with a resultant under capacity. THE END

NEW POWER: What's Happening in Quebec Province

By EDMUND T. NESBITT

ALUMINUM COMPANY's Chute des Passes project on the Peribonka River, north of Lake St. John and about 275 miles northeast of Quebec City, is now well advanced. The unusual underground powerhouse will have five generators of 200,000 hp each, which will add 1,000,000 hp to Alcan's generating facilities in the Saguenay district.

First unit is to be in service next year; the whole project will be completed in 1960, including the 30,854-ft long, 43-ft 4-in.-diam supply tunnel, and curved tail race tunnel 9000 ft long.

Powerhouse is to be 470 ft underground. This will give the turbines an operating head of 540 ft. Depth of the generating station underground was necessary due to the too gradual slope of the watershed from the storage dam at Passe Dangereuse, about six miles north of the power plant.

The new generating station is about 150 miles from the big Aluminum Company smelter plant at Arvida, on the Saguenay River. Its five generators will increase the total power output of the Aluminum Company's power generating facilities in this area to 2,580,000 hp, including the big Shipshaw development near Arvida.

Another power project now well advanced is the Shawinigan Water & Power Co's dam and generating station at Rapide Beaumont on the St. Maurice River, about 12 miles north of LaTuque and about 100 miles north of the St. Lawrence River. This is a six-unit plant which will generate 246,200 kw to boost the total output of the Shawinigan system in the St. Maurice Valley to 1,500,000 kw. This power serves most of the 200 industries in the Shawinigan Falls, Grand'Mère and Trois Rivières district, including several pulp and paper mills, chemical plants and textile mills.

Hydro-Quebec has started work on Bersimis No. 2 generating plant on the Bersimis River, about 235 miles east of Quebec City. This is about 40 miles south of Bersimis No. 1 plant. No. 2 station will be a five-unit plant and will produce 637,800 kw. No. 1 plant is nearing completion. It will have eight units of 111,900 kw capacity each, five of which have been installed, will be in full operation by the end of 1958, with a total output of 1,200,000 hp. No. 2 plant will take about two years to complete.

Hydro-Quebec's newest — No. 3 Beauharnois powerhouse on the St. Lawrence River, about 40 miles west of Montreal and part of the St. Lawrence Seaway power system — will be completed in about a year. This will be one of the world's largest hydroelectric plants, with the existing Beauharnois No. 1 and No. 2 plants supplying 1,425,000 hp, and the new No. 3 plant generating about 810,000 hp, to bring the total output of the three plants to 2,236,000 hp.

When Hydro-Quebec's two Bersimis plants are in full operation they will produce more than 2,000,000 hp, bringing the total of the Beauharnois and Bersimis output to about 4,500,000 hp.

Most of this power will serve Montreal industries. Power from Bersimis plants No. 1 and 2 is being brought overland via Quebec City, where a large transformer station has been completed.

Many other smaller power developments are being built in other parts of Canada.

Bowaters Corp of North America, which has a large pulp and paper mill at Cornerbrook, Newfoundland, and owns a power generating plant at Deer Lake, about 50 miles inland from the west coast mill, has started construction of another hydroelectric plant on the Cornerbrook River, about ten miles from the mill. This will add about 200,000 hp to the present power capacity, enabling the company to supply power to new commercial developments in the Cornerbrook area. The existing Deer Lake plant supplies power to Cornerbrook and nearby villages.

"Oh-Oh—looks like another major economy program has been inaugurated!"

New College Campuses Feature Up-to-Date Power Utilities

MODERN TRENDS in college campuses are well-illustrated by three colleges which were placed in the enviable position of relocating on entirely new tracts. New construction and graceful landscaping make these campuses among the most beautiful in the country.

Power engineering for these schools shows a variation which might well be expected, since each system was designed according to individual desires, and local conditions.

Because its growth was planned over a number of years, the original scheme for a central heating system at Colby College, Waterville, Maine, was abandoned. Instead, its buildings are heated in groups, as illustrated in the figure. There are six major boiler rooms under this plan, each with oil-fired low-pressure steam boilers. Steam and return lines between buildings are underground.

On the other hand, when Wake Forest College relocated in Winston-Salem, N. C., a central heating plant was constructed. Steam at 120 psig passes through cast-in-place concrete steam tunnels connecting all of the major buildings. Heat is supplied in the local areas by forced-circulation hot water from instantaneous heat exchangers.

H-P, H-T Hot Water

It is interesting to note that one group of ten apartment buildings housing 72 faculty families is heated by a high-pressure, high-temperature hot water loop supplied by a pump and converter in the nearest dormitory. The buildings are approximately 1000 ft from the dormitory housing the converter, and the buried loop is insulated with Gilsonite.

Steam generating equipment at Wake Forest, which is the largest of the three colleges, includes two 55,000-lb-per-hr water tube boilers, burning coal on continuous-cleaning-type stokers and grates.

Goucher College moved from ancient buildings in downtown Baltimore to a rolling tract in suburban Towson, Md., and adopted the individual-unit heating system. Oil-fired boilers supply low-pressure steam. One exception to the unit system is the boiler in the Library Building, which also heats the Science Building.

Electrical Systems

Goucher purchases all of its power at distribution voltages, one meter being used for the entire college. A survey this spring may result in the installation of a substation to enable the purchase of high-voltage electricity. Ninety per cent of the power lines are underground. Each building has an individual transformer vault.

At Colby College electricity is purchased at 4100 volts, and distributed to six transformer vaults, serving approximately the same groups of buildings as the heating systems. Most of these lines are underground. Eventual usage service is three-phase, four-wire, 120–208 volt.

Primary voltage of 12,400 is stepped down to 4160 in a substation owned by the power company and located on the Wake Forest campus. From here it is distributed underground at 4160 volts, to the various buildings where it is transformed to 120–208 for local service.

Air Conditioning

Offices, classrooms, public gathering areas and dining halls are air conditioned at Wake Forest, southernmost of the three colleges. Dormitories, the gym, laboratories and apartments are not. Large buildings are multi-zoned from central units. Library stacks, in addition to the usual mechanical filtration, are supplied with air which has passed through both electrostatic and charcoal filters. Total air conditioning amounts to about 900 tons.

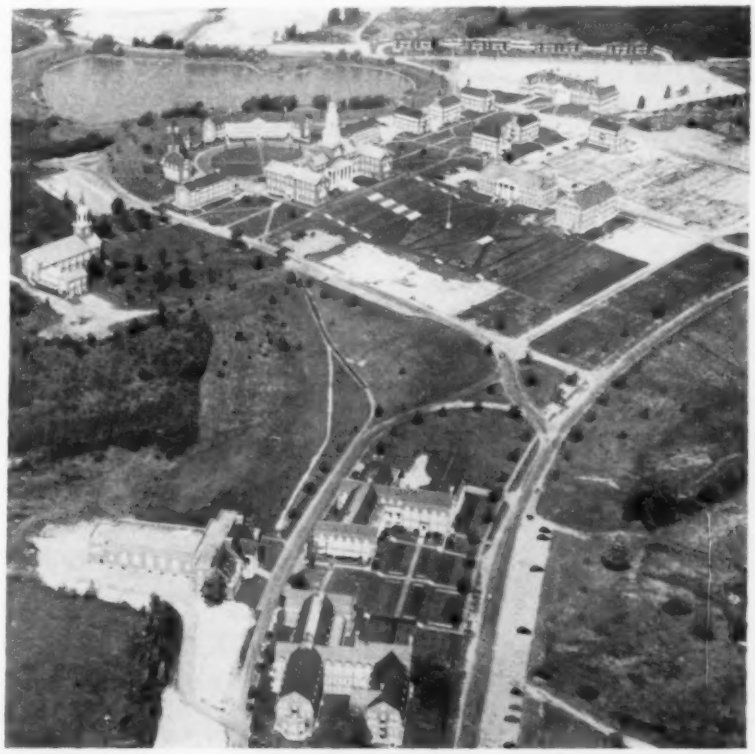
An unusual feature is the 50-ton compressor for the auditorium of the chapel, which builds ice in storage tanks for peak load periods.

At Goucher College and Colby there are no central air-conditioning systems, but local window or floor units are used in offices, gathering places and elsewhere as desired.

Other Utilities

All three of the colleges purchase city water, and two of them use public sewerage. The third, Colby College, disposes to the outflow from Messalonskee Lake, which then enters the Kennebec River.

Each of the colleges leases multi-trunk telephone equipment from a local company. In addition to this, intercommunication systems are used in areas where required. THE END



Beautiful new campus and artificial lake of Colby College. Five boiler plants serve the buildings shown, in the following groups: 1, lower left, women's dorms, union and gym; 2, center left, chapel; 3, upper center, library (with tower) and men's dorms; 4, upper right, union and fraternity houses; and 5, center right, science and biology-geology group. Faculty apartments are in far background

Fig. 1. At Central Station session, front row, l to r: Chairman Philip Sporn, president AG&E; T. T. Frankenberg, head Mech. Eng. Div., AG&E Service Corp; J. D. Andrew, Jr. application engineer, B&W; E. B. Morris, chemical section head, AG&E Service Corp; H. L. Solberg, head, School of M.E.; Purdue Univ. Second row, l to r: A. G. Lloyd, staff engineer, ME Div., AG&E Service Corp; R. Sheppard, Mgr. Turbine Product Eng., General Electric; P. H. Koch, application engineer, B&W

APC at Chicago Attests Power Field's Vitality

COVERING present and anticipated developments in every phase of power engineering, the 20th Anniversary meeting of the American Power Conference was held in Chicago at the Hotel Sherman, on March 26, 27 and 28. Some 2400 power engineers from all over the country took part in this, the only national conference devoted exclusively to the problems of the power industry. It is sponsored by the Illinois Institute of Technology in coöperation with nine other Midwestern engineering colleges and with many technical societies. The Conference is directed by Dr. R. A. Budenholzer; and the secretary is E. R. Whitehead, both of IIT.

Technical papers at the Conference covered a wide range of subjects including steam turbine generators, operating experience with the first supercritical steam-electric unit at Philo, boiler feedwater treatment and deaeration, fuel burning, gas turbines, high-voltage transmission, use of computers and, of course, nuclear energy.

Fig. 2. J. W. McAfee, president Edison Electric Institute, and president Union Electric Co, addresses APC-ASME group

Discussing steam turbines for nuclear plants, J. A. Carlson showed details of their design and showed how, with certain types of nuclear reactors, the problem of moisture in the steam had to be met in the design and construction of the turbine. He described the Shippingport turbine, the Yankee unit and the Indian Point unit.

Operating experience with the 4500-psig, 1150-F Philo unit shows it has met the expectations of the designers, said R. Sheppard. The turbine has not been opened for inspection of its internal steam path parts because of its excellent performance to date. Bearings and valves have been inspected and the author gave details of their condition. G. D. Andrew, Jr, P. H. Kock and E. A. Pirsh described the once-through 670,000-lb-per-hr 4500-psi, 1150-F universal-pressure steam generating unit, its internal bypass system and its control. Boiler feed pump speed provides the water flow and turbine throttle position controls the pressure. Firing rate controls steam temperature; reheat temperature is controlled by dampers; and all controls are interlocked to protect against firing without at least ⅓ water flow. The unit was acid cleaned before start-up. Despite a few difficulties, the unit has been flexible and responsive and the authors are very optimistic about the future of the type.

Lawrence H. Carr and Wm. F. Crawford advocated a new 4500-psi standard for valves to meet the supercritical plant development. They showed how such valves could be designed, said even 4500 psi might be conservative.

Use of an automatic digital data collecting system for turbine cycle testing on the Philo supercritical unit was described by H. T. Hoffman and A. S. Grimes; while a similar use of a digital computer for performance testing of an Eastlake 250,000-kw, 2400-psig, 1050-F unit was detailed by Richard G. Schuerger.

Industrial power plants received attention in several interesting papers, more details of which will be given in subsequent issues. A. A. Cummins discussed design of small industrial power plants to secure maximum net earnings. After showing the calculations to prove how a typical industrial power plant can pay off, he gave comments on design from the consulting engineer's point of view, and reviewed equipment design.

In small plants, with boilers of 60,000 to 200,000 lb per hr, he said, operators favor the spreader stoker, which permits wide load swings, although pulverized coal is also considered. Semi-outdoor design, he said, has lower cost and less maintenance. Proper feedwater treatment, metering controls, coal handling equipment and other details are covered. When a power plant is designed to give minimum waste of Btu when generating power, satisfy the production needs, is made simple but efficient by using semi-outdoor construction and compact arrangement to reduce investment and operating cost, then the owner will secure maximum net earnings.

Some new ideas for power plant coal handling were presented by Arthur J. Stock. These included discussion of special coal trucks and railroad coal cars with compartments for handling ash; incorporation of coal silos into the building design to save space and minimize coal freezing; use of outdoor active coal piles, use of a new device, a layer loader, for coal supply to stoker hoppers, also a traveling car for stoker supply. Some of these devices are in use, others are still in the idea stage.

Short-cut methods of evaluating alternate steam and power supplies

for industrial plants were explained by W. B. Wilson and D. L. E. Jacobs. Because heating and process steam must often be provided in any case, many plants can afford to use this steam in generating electric power. To do so, proper steam conditions must be selected; the authors gave curves and calculations for doing this, and showed how to figure fuel requirements, turbine power, and extraction steam quantities for process.

Of interest was a discussion of high energy propellants by C. C. Miesse and P. Lieberman. The turbo-furnace for multi-fuel firing was detailed by C. Freeman Hawley. Installations were described in which fuel oil, refinery gas and fluid coke are burned.

Various methods of conducting underground gasification of coal in this country and abroad were explained by C. D. Pears, J. P. Capp and Milton H. Fies, including the stream method, blind borehole, electrolinking and pneumatic linking, fluid injection, use of oxygen, air and steam. Earlier work was directed to producing transportable gas. Today, the end sought is on-the-site-generated electric power.

Pumped storage hydroelectric power was covered in one session. The general conclusion was that it should be considered carefully in system planning.

Fig. 3. At All Engineers Dinner, l to r: Allen Van Wyck, president, Illinois Power Co; Dr. John T. Rettaliata, president IIT; C. H. Linder, vice-president, G-E; W. L. Cisler, president, Detroit Edison

Fig. 4. L to r: F. R. Barnett, Richardson Foundation; C. L. Wilson, Univ. of Missouri; M. S. Luthringer, Central Ill. Public Service; B. G. Elliott, Dept. M.E., Univ. of Wisc.; Rev. R. G. Dunlop, N. U.

There is an immediate need for the gas turbine power unit for peaking and stand-by service as well as special cases of base load generation, said W. H. Ferguson and R. E. Strong. The gas turbine combined with the steam cycle is potentially the next big step. W. D. Marsh discussed integration of the gas turbine with other generation in an economical utility generating system. Joseph E. Parker gave details of the way in which a gas-turbine-power-industrial cycle was worked out for Texas City. This plant develops 275,000 lb per hr of 1000-psi 850-F steam from the exhaust gas of a 7000-kw gas turbine, the exhaust being considered combustion air for firing gas in the boiler. Overall thermal efficiency of the cycle is calculated to be 77 per cent.

Four sessions on water technology covered deaeration, ion exchange and water analysis and control.

There was detailed treatment of high-voltage transmission application of vacuum switches, substations and power transformers, air pollution problems, central station ventilation, uses of computers in testing and system operation, and two sessions on nuclear energy problems. THE END

ASME Gas Turbine Power Division Finds Progress Rapid

AN ENGINE of over 1000 hp which can be easily carried by two men, a super-charger which uses the pneumatic energy of exhaust gases in direct contact with the incoming fresh air to pressurize it, and remote desert pumping stations started, controlled, and monitored by radio, were among developments described to well over 700 engineers at the Washington conference of ASME's Gas Turbine Power Div.

Theme of the meeting was struck by Glenn B. Warren, General Electric v-p, chief speaker at the banquet, who traced the history of the gas turbine, and pointed to its versatility as a prime mover. Mr. Warren was well-qualified to look into that history, as he has been personally interested in it for at least 44 years.

Versatility of the gas turbine was well brought out in Mr. Warren's talk, but it was also evident in the exhibits, and in the 24 comprehensive papers presented.

Industrial Use

Because the gas turbine has the unique ability not only to produce mechanical or electrical power, but also to serve as a source of hot gases or to utilize waste heat, and can perform any combination of these functions simultaneously, it finds a great variety of uses in industry.

Discussed in one paper was the gas turbine to be furnished by Westinghouse to U. S. Steel's South Works (Chicago), which will be fueled by low-heat-content gases, and be used to furnish compressed air to the furnaces.

In an accompanying paper, Z. Stanley Stys, Brown-Boveri, dis-

Fig. 1. Dinner speaker Glenn B. Warren (center) talks with Lt Gen C. S. Irvine, USAF, and ASME Pres James N. Landis

Fig. 2. Editor Chester Earle (right) discusses popular opening session with H. R. Hazard, chairman, Gas Turbine Div

Fig. 3. T. J. Putz, session chairman, visits with Dr. Robert Huber of Paris, who spoke on the future of free pistons

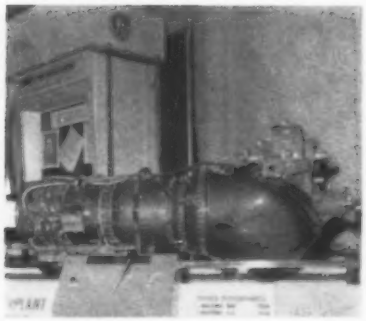


Fig. 4. Small but powerful package, G-E T58 engine is rated at more than 1000 hp, yet weighs 267 lb, a 4-to-1 ratio

Fig. 5. Solar exhibit, part of international field. 500-hp Jupiter in Navy craft gave engineers a fast boat ride

cussed the historical aspects of gas turbines in steel mills, particularly in Europe, where considerable performance and operating data has already been accumulated. He described how this information is being used in consideration of the present state of the gas turbine art to develop new and better machines and systems.

Components and Fuels

Occupying a considerable portion of the time of the gas turbine engineers, who had gathered from four continents, was the discussion of component parts, and the materials from which they may be made. Highly interesting developments were reported in both design and metallurgy. Regenerative heaters, adjustable stator blades and combustion chambers with conformation giving an increase in pressure were subjects of separate papers.

Successful field tests of the Comprex supercharger were discussed by representatives of ITE Circuit Breaker. This amazing device, which was the subject of an article in POWER ENGINEERING in July, 1947, performs by admitting fresh air into one end of a tube, letting hot exhaust gases rush into the other end, and conducting the then-pressurized fresh air into the engine as it is forced out of the tube.

Fuels were a subject of great interest. Varying from crude oil to nuclear energy, all aspects of source, composition, treatment, use, and effect on components were discussed by the speakers and their unusually-spirited audience.

In aircraft, a virtual monopoly of both the civilian and military fields has been pre-empted by the gas turbine, at least in the near future. Amazing horsepower-to-weight ratio of over four-to-one is a feature of the General Electric T-58 engine, shown in Fig. 4. This model, now in prototype production, was exhibited and also described in a paper.

While it was designed and is being used primarily for helicopters, it is readily adaptable to any use in which its low weight and small size (267 lb, 55 in. long, 15 in. diam) is required or desirable for an engine of its power (1000-plus hp). It is rugged, relatively low in cost, and easy to maintain.

Other Forms of Transport

Nor is aircraft the only means of transport where the gas turbine has made important contributions. First paper of the conference described the unattended pumping stations of the Trans-Arabian Pipe Line. There six new 5000-hp units help the original diesels to move 450,000 bbl per day of crude oil 754 miles through a 30-in. pipe line.

Remote compressors, some of which are more than 50 miles from the nearest operator, are completely controlled by radio. Availability has run exceptionally high under conditions considerably less than ideal. These units were built to supply the following unique requirements:

1. 5000-hp output, continuous at 110 F, 2600-ft elevation (6000 bhp attained);
2. Fueled with crude directly from pipeline;
3. Suitable for unattended operation with supervisory controls 50-100 miles away;
4. Portable to permit rotation of units and overhauls at central shop.

Navy Tour

Gas turbines in transportation were discussed in several other papers, and were very much in evidence during a tour of the Naval Gun Factory. There engineers were privileged to ride in a U. S. Navy personnel craft powered by a 500-hp Solar Jupiter, and to experience its outstanding performance.

Also displayed were gas turbines in use for various auxiliaries, both in ship and shore installations, and a 200-hp regenerative gas turbine installed in a Chevrolet truck.

A model of the engine room portion of the Liberty ship *William Patterson* attracted considerable attention. Shown in Fig. 7, this power plant is a combination of free-piston gasifiers driving a gas turbine for main propulsion.

An award was made at the conference to LeRoy F. Deming for "valued services to the Gas Turbine Division". It was presented by James N. Landis, president, ASME. Mr. Deming is Head, Power Generating Section, Bureau of Yard and Docks, U. S. Navy. THE END

Fig. 6. Part of exhibit hall and a few of the visitors. Exhibits filled hall and overflowed into adjoining parlors

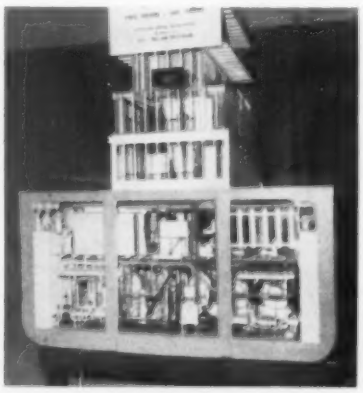


Fig. 7. Model of engine room of Liberty ship *Wm Patterson* with 6000-shp gas turbine, free-piston gasifiers

Fig. 8. Gas turbines driving electric generators feature light weight, easy, reliable starting, automatic controls

CONSTRUCTION NEWS

San Francisco, Calif. — Pacific Gas & Electric Co, 245 Market Street, has plans under consideration for the construction of an atomic power reactor designed to produce electricity at a price competitive with conventionally fueled generators. New installation will have an initial capacity of 60,000 kw and is tentatively scheduled to be placed in operation by mid-1962. Work will begin as soon as plans and engineering of the entire project are completed. New plant will be a boiling water reactor and produce steam around the reactor's fuel elements instead of via a heat exchanger. The steam will then operate turbines that will produce the electricity. Bechtel Corp will design and construct the new unit.

Peoria, Ill. — Central Illinois Light Co, 316 S Jefferson Ave, has plans under way for construction of new steam-electric power plant on the Illinois River, south of here. Installation of the first unit, which will have an initial capacity of 125,000 kw, will get under way at once for completion in 1960. New unit will be of the latest reheat type and will operate at a steam pressure of 1800 psi and at a temperature of 1000 F. Plant when completed will cost approximately $62,000,000.

New Albany, Ind. — Public Service Co of Indiana, Inc, 1000 E Main St, Plainfield, Ind., has announced a total construction program for 1958 estimated at about $46,778,000. Company's construction program has been expanded to provide for the installation of two additional steam-generating units at local station here, each with an initial capacity of 150,000 kw. These units are scheduled to be placed in service by late 1960 at a figure reported to be approximately $62,000,000, including complete installation, transmission lines and substation facilities.

Lake Charles, La. — Continental Oil Co, Houston, Tex., has plans under way on construction of a new crude oil refinery, with a daily capacity of 52,000 barrels of crude. Company has awarded contract to Babcock & Wilcox Co, Boiler Division, to build and erect the boilers, which feature a special design that allows boilers to operate initially with conventional fuel and then switch over at company's convenience to utilize hot gas turbine exhaust for combustion. The arrangement will enable the company to employ a gas turbine at the refinery and to reclaim and use heat which otherwise would be wasted in the exhaust gases.

Baltimore, Md. — Baltimore Gas & Electric Co, Lexington Bldg, has announced major expansion of company's facilities through 1958. Company has appropriated $17,000,000, for expansion and improvement of electrical distribution system including the construction of eight new substations, alterations and improvements of seven existing substations. Company also has under way, installation of second steam-electric generator with initial capacity of 125,000 kw at Herbert A. Wagner steam generating plant. Work is progressing rapidly for completion in 1959. Company also plans to spend an amount approximating $8,000,000 for additions and improvements to gas utility system.

Fergus Falls, Minn. — Otter Tail Power Co, 125 Mill St S, has awarded a contract for the installation and completion of a 53,500-kw steam-electric generating unit to the Fegels Construction Co, Inc. Contract estimated to be about $2,000,000, calls for all labor and material necessary to complete the building to house the unit, as well as the installation of all machinery and equipment. Contract for this work is the last major contract for the completion of the $11,000,000 project.

St. Louis, Mo. — Union Electric Co of Missouri, 315 N 12th Blvd, has announced contract award to the Foster-Wheeler Corp, for the construction of the largest single-furnace steam generator ever built. New generating unit to be installed in the Meramec Station of the company will have a capacity of 2,310,000 lb of steam per hour at a pressure of 2200 psi and a temperature of 1010 F. New units to be installed will increase company's total capacity by one-third at a reported cost of $117,000,000.

Warrensburg, Mo. — Missouri Public Service Corp, Hout Bldg, has preliminary engineering work under way for the construction of a new steam-electric generating plant on local site. Construction of first unit with an initial capacity of 88,000 kw will begin at once for completion by early 1960. Installation including high-pressure boilers and auxiliary equipment will cost in excess of $20,000,000.

Omaha, Neb. — Omaha Public Power District, 17th & Harney Sts, has plans under way for addition to steam-electric generating station at North Omaha Power Station. Work will include installation of a new turbine-generator with initial capacity of 125,000 kw, high-pressure boiler and auxiliary equipment. General Electric Co's Apparatus Sales Division has been awarded contract to build the turbine-generator at a cost of $4,473,800. New unit is expected to be placed on line early in 1960.

Sayreville, N. J. — Jersey Central Power & Light Co, 501 Grand St, Asbury Park, N. J., has installation under way on a new steam-electric generating unit with a total capacity of 137,500 kw. Unit is being installed in the new $20,000,000 addition to present station facilities now under construction and scheduled for completion by early 1959. When placed on line, the total generating capacity of company's system will total 509,000 kw, more than triple capacity of company's system ten years ago.

New York, N. Y. — Port Authority State of New York, 10 Columbus Circle, has awarded construction of main powerhouse structure of the Niagara project at Lewiston, near Niagara Falls, N. Y. Work will encompass construction of a large powerhouse 1100 ft long and its forebay which will be cut into the 310-ft cliff at the edge of the Niagara River. Contract award went to Merritt, Chapman & Scott Corp. Westinghouse Electric Corp will furnish the 13 electric turbine generators required at the project, each with a rated capacity of 167,000 kva of electricity. First unit will be delivered in the fall of 1959. Maximum capacity of 1,800,000 kw will make Niagara project second largest hydroelectric plant in the U. S.

Painesville, Ohio — Department of Electric Power & Light, City Hall, has awarded contract to R. Ralph Hadlow, Hippodrome Annex, Cleveland, for installation of new boiler and auxiliary equipment in municipal power plant. Cost reported to be about $1,375,000.

Muskogee, Okla. — Callery Chemical Co, 230 N Braddock St, Pittsburgh, Penna., has awarded contract of $10,300,000 to H. K. Ferguson, Cleveland, O., and Macco Construction Co., Paramount, Calif., for construction of the seventh section of company's high energy fuel plant. Work will include processing units for the high energy fuel contracted for by the Department of the Navy, steam boilers and auxiliary equipment, engineering buildings and a large laboratory. Ralph H. Parsons Co is engineer of the project.

Troutdale, Ore. — Reynolds Metals Co, Richmond, Va., announced completion of arrangements for Bonneville Power Administration to transmit over its lines power supplied by California Oregon Power Co., Medford, Ore. Contract makes available for purchase and use by Reynolds aluminum smelting plant at Troutdale, Ore., 65,100 kw of firm power with the amount to be increased to 95,200 kw by July 1, 1959. Bonneville will continue to supply additional power to the Troutdale plant and to a similar Reynolds facility at Longview, Wash.

Portsmouth, R. I. — Newport Electric Corp, 159 Thames St, Newport, R. I. has plans under consideration for the construction of new power plant here. New plant will be known as the Arnold Point power plant and construction will start late this year. Proposed to cost in excess of $1,000,000.

Littlefield, Tex. — Lamb County Electric Coöperative, Inc, has authorized plans and work is under way on the installation of new 24.5-mile electric distribution line. Company also plans the installation of two new 3,750-kva and one 1500-kva substations along with other system improvements at a reported total cost of $1,606,000.

Correction Note: Public Service Co of Indiana, Inc, has moved its headquarters to 1000 East Main St, Plainfield, Indiana. Previous references to that company in these columns incorrectly gave the address as Indianapolis.

Correction note: Ford, Kentucky — In the item under this heading in Construction News, page 124, February 1958 issue of POWER ENGINEERING, it was stated that East Kentucky Rural Electric Coöperative Corp has plans under consideration for construction of a fourth steam-electric generating unit at the company's Winchester power plant. It was incorrectly stated that Burns & McDonnell Engineering Co was consulting engineer. We are now informed that Stanley Engineering Co was the consulting engineer on the installation of the third unit at this station and has been retained as consulting engineer for the installation of the fourth unit, a 66,000-kw unit similar to No. 3. Work has not yet started, but is expected to get under way within the next few months, with completion scheduled for early in 1961.

Power Engineering handbook

beginning

Introduction to Steam Power

Course developed by R. A. Dannells, F. W. Beeman, J. B. Burkhardt and the late J. R. Bonnell, of Commonwealth Edison Co

Steam Power Plant Process

1. Energy cannot be created or destroyed, but can be changed from one form to another. Heat and electrical energy are in the ratio of
   3412.75 Btu = 1 kwh
2. The steam power plant exists for the purpose of converting energy from a dormant state to a useful one.
3. This conversion is accomplished with difficulty, and then only at the expense of the *loss of a major portion of the heat energy.*
   a. Plant operating problem is to reduce and hold these losses to a minimum.
4. General formula for efficiency of any machine or energy converting device is:
   Efficiency = useful energy output / total energy supplied

Methods of Producing Electrical Energy

1. Water power
   a. Water may be impounded by natural or man-built barriers.
   b. The head of water thus produced can be made to do the work of turning a water wheel.
   c. The water wheel is directly connected to an electric generator.
2. Steam engine
   a. Fuel is burned under a boiler, the heat being absorbed by water to produce steam which drives an engine.
   b. Limited in capacity, steam temperature and back-pressure.
   c. Has reciprocating parts.
3. Steam turbine generator
   a. Over 60 per cent of all electrical energy produced in United States is by steam turbine generators.
4. Internal combustion engine
   a. Uses gas, gasoline, or fuel oil.
   b. The type most used in power production is the diesel or fuel-oil burning engine.

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fold along this line—outside edges toward you

Satisfied with your training of power plant operators?

Here's material to use in helping the new man in your plant understand his job better—and so achieve better performance. This article begins a series on steam power fundamentals, which will be featured in the Handbook over coming months. This streamlined course is the result of 20 years of experience in presenting the technical why's of the subject to men in Commonwealth Edison Company plants. We think you will find the semi-outline form of the information to be an effective way of presenting it to your crew.

1 — Introductory Aspects of Power Generation

   c. Diesel engines give excellent performance up to 5000 hp or 3730 kw.
5. Gas turbines
   a. The hot gases of combustion go directly to the turbine where they expand and the heat energy is converted into mechanical energy at the turbine shaft.
   b. No boiler used. Limited to oil and gas fuels, at present. Coal gas turbine in development stage.
6. Nuclear energy
   a. Atomic power plants are beginning to be an accepted part of the American power field.
7. Wind, tide, sun power
   a. Limited amount of research and development being done on these three methods.

Steps in Producing Electrical Energy from Burning Coal

1. Fuel to heat
   a. Combustion — transformation of potential energy in fuel to heat energy in the gaseous products of combustion.
   b. Losses — unburned fuel.
   c. Related problems include securing and preparing coal, analysis of coal, ash and flue gas analysis.
2. Heat to steam
   a. Heat transfer from furnace to the water and steam within the boiler.
   b. Losses — various heat losses, chiefly stack gas loss.
   c. Related problems include analysis and treatment of feedwater, properties of steam, heat recovery apparatus.
3. Steam to mechanical motion
   a. Transformation of the heat energy of steam to the mechanical motion of the rotating turbine spindle.
   b. Losses — friction losses and heat loss to the condenser cooling water. Heat loss to the condenser cooling water represents the largest single item of energy loss.
4. Mechanical motion to electrical energy
   a. Transformation of mechanical energy in the rotating spindle to electrical energy.
   b. Losses — friction, windage, and electrical.

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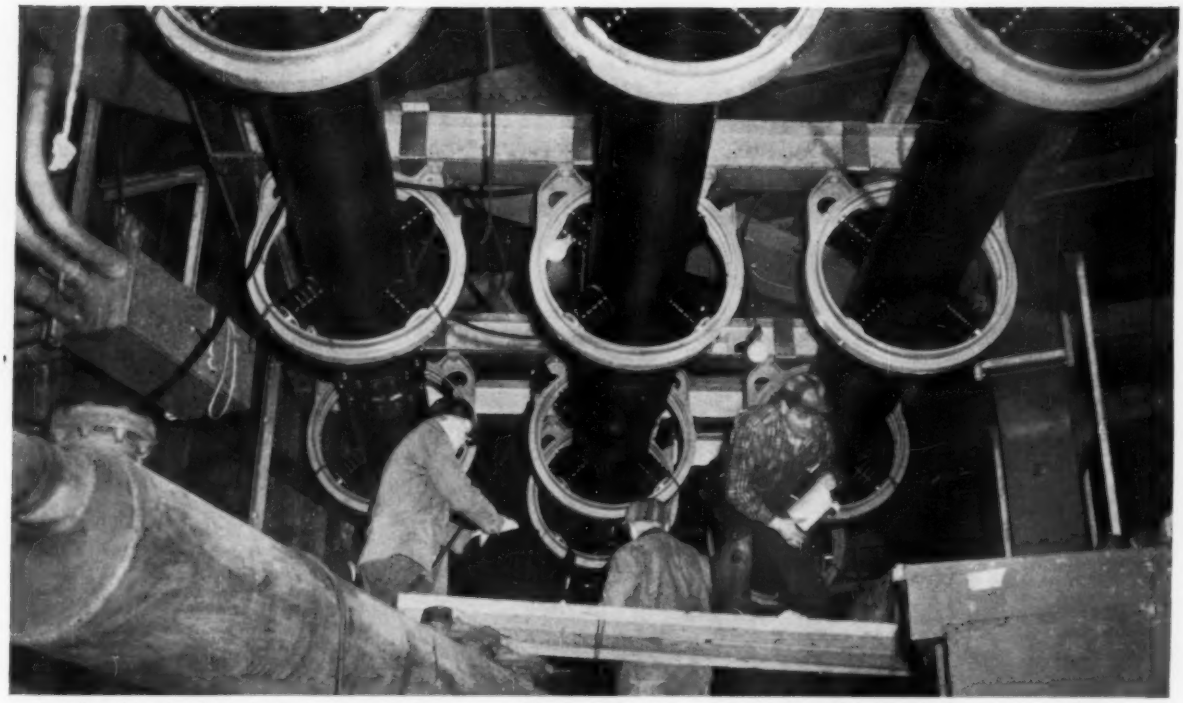
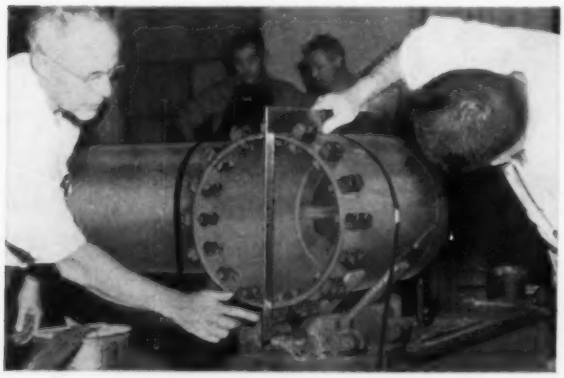


Installing the self-cooled isolated phase bus structure to carry 6500 amps at 20 kv from the generator to the power transformers at Steam Turbo-Generator Unit #3 at the Astoria Station of the Consolidated Edison Co. The tubular copper bus, 13½" O.D., .406" wall thickness, is wrapped with black insulating tape prior to installation.

Big Tubular Copper Bus Carries 6500 amps at 20 kv

At its #3 Steam Turbo-Generator at Astoria, L. I., the Consolidated Edison Company uses these large Anaconda tubular copper conductors to carry generator output to the power transformer. These special conductors are another example of how Anaconda can help meet special conditions. Though well beyond the standard-pipe-size copper bus tube, they are by no means the largest. Anaconda can produce seamless copper tubes up to 26 inches, I.D.



13½" O.D. x .406" tubular bus being fabricated at R & I E Equipment Div. of I-T-E Circuit Breaker Co., Greensburg, Pa. Everdur® nuts are silver-alloy brazed inside the tube and the bolts withdrawn. Then in assembly at the site, the nuts are in place for fast, easy installation. A total of 1,128 feet of tubular bus was required.

In general, where mechanical requirements permit, bus costs can be cut through the use of tubular bus conductors with low wall-thickness-to-diameter ratios. The weight of metal purchased goes down as the t/d goes down. Round tubes in the standard pipe dimension, and thin-wall sizes, also offer other advantages. They make it possible for you to utilize the great variety of stock sizes of supports, connectors, clamps, and other line hardware.

TECHNICAL SERVICES. Anaconda specialists are available to help you in the solution of technical problems involving the use of Anaconda Bus Conductors. For such service, or for a copy of Publication C-25, see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn.

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COPPER CONDUCTORS

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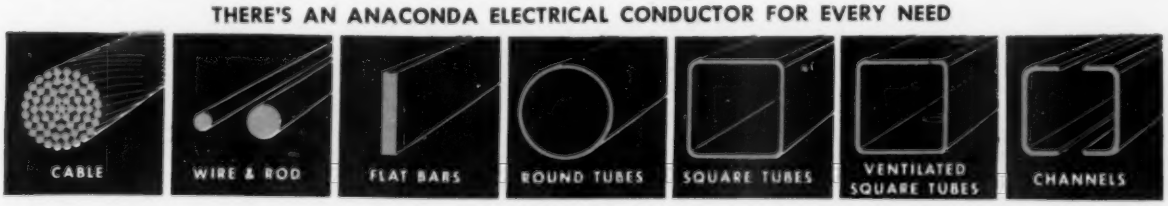
THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED



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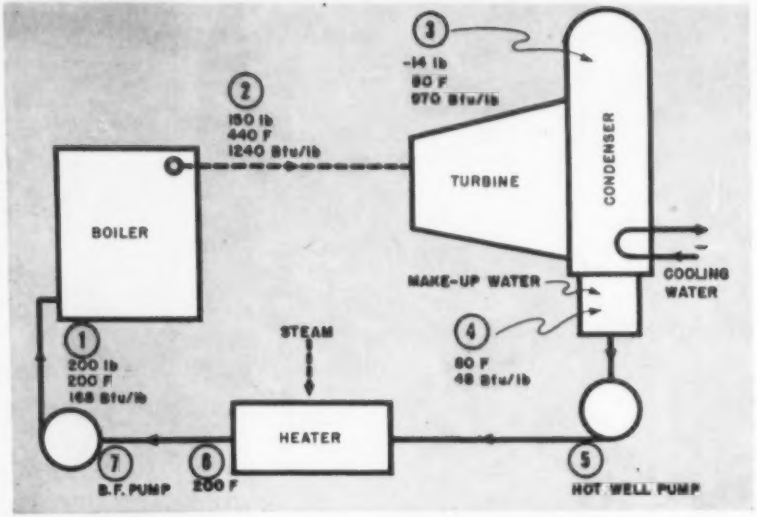

Simple condensing cycle showing steam and water flow. Numbers correspond to items in text below

Relationship of Major Equipment in a Power Plant

The following numbered items correspond to numbers in the drawing.

1. Water is supplied to boiler at 200 lb, 200 F containing 168 Btu of heat units per lb.
2. Water has been heated, evaporated to steam and superheated to 440 F at 150 lb, now contains 1240 Btu.
3. Steam has expanded through the turbine to a pressure below atmospheric and 80 F, now contains 970 Btu.
4. Steam has been condensed to water so it may be returned to the boiler. It now contains 48 Btu.
   a. 922 Btu of heat has been lost to the *condenser cooling water*.
   b. Make-up water is treated and supplied to the hot well to replace steam and water losses in the cycle.
5. Water is pumped from hot well to heater.
6. Water has been heated from 80 F to 200 F by means of bled, process, or exhaust steam.
   a. 120 Btu of heat has been added in the heater, thus reducing the amount of heat to be added by the boiler.
7. Water pressure is raised by boiler feed pump so it may be forced back into boiler.

Growth of Steam-Electric Power

1. Capacity of equipment
   a. Boilers — from a few thousand pounds of steam per hour to over 1,000,000 lb of steam per hour.
   b. Turbines — from 5000 kw to 250,000 kw.
2. Steam pressure
   a. From 175 psi to 1800 lb generally, with a few installations at 2300 lb. One boiler is now in operation at a pressure of 4500 lb.
3. Steam temperature
   a. From 475 F to 1100 F.
4. Station efficiency
   a. From 70,000 Btu per kwh to about 10,000 Btu per kwh.

Next month — Fuel Supply

fold along this line—outside edges toward you

12 Tips on Gas Meter Repair

TWELVE TIPS on repair and reconditioning of industrial gas meters are offered by Rockwell Manufacturing Co engineers. To restore old meters to service they recommend:

Valve-Grinding

Emery or carborundum paper carefully mounted on heavy plate glass blocks provides as true a surface as is possible to obtain commercially. Either wet or dry paper may be used, and should be brushed often when grinding to keep specks of metal from accumulating. The emery paper is attached to the block by use of shellac or sealing wax; it is important to get a thin, even coating in order to maintain flatness.

Grinding Thickness

Size of the block being used for grinding should be larger in area than the valve or seat being ground. In the case of domestic cast meters, a block large enough to grind both valve seats simultaneously is recommended.

Care should be exercised to keep the block flat while grinding. A minimum of material should be removed and a figure 8 grinding motion will produce a very good finish. No. 80 grit paper is satisfactory for a rough grind and finishing should be done with a No. 150 grit paper.

Cleaning of Valves and Seats

In many instances, just a thorough cleansing of both valves and valve seats is sufficient to put the meter in first class working order. This cleansing can best be performed by use of solvents such as benzene, alcohol, naphtha.

Checking for Flatness

The reverse side of the glass block which was used for grinding has a very good surface for checking valves or valve covers for flatness. If opposite corners of the block are tapped with finger tips when the block is so placed on the valve, rockiness or uneven grinding can very easily be detected.

Cements for Seat to Plate Sealing

Shellac or a glyptol type of cement are both satisfactory for sealing this joint. Glyptol is easier to work with.

Reoiling Diaphragms

A mix which is very acceptable for reoiling of diaphragms would be a 4:1 ratio of Acme D oil to petrolatum. This mixture should be heated to approximately 140 F before applying.

It is recommended that the leathers be swabbed or sprayed rather than completely immersed in this dressing. An over-oiled diaphragm will be extra soft and flabby and will result in a greater meter proof change.

Grease for Packing Boxes

A non-fluid type of oil having a consistency of cup grease can be used very satisfactorily in packing boxes to aid in lubricating felts and preventing leakage.

External Cleaning

A caustic base stripper gives very good results in cleaning paint from meters. Other methods used for removal of rust and other foreign materials are sand blasting, or "wheel-abrating."

Meter Paint

A very satisfactory meter paint is a quick drying enamel with an epoxy resin base. This results in a very good protective coating and, due to its quick drying properties, facilitates meter handling in the repair shop.

Proving Techniques

Within the proving room itself the temperature should be constant — that is, the temperature of the air, the oil in the bell, and the meters themselves should be within plus or minus 1 F for accuracy.

The bell prover itself should be clean, level, and free of binds. The air being passed through the bell for the meter proving should be taken from the proving room itself in order to maintain temperature balance. The prover should also be regularly bottled in order to check and maintain its degree of accuracy.

Meter Balance

Gas meter is similar to a combustion engine, and in order for it to maintain its ultimate performance it must be kept in balance to operate and run smoothly. Primary sources of unbalance are posi-

cut along this line

Look again

At the New, Field-proved Quantichem Instrument

Here is a unit that automatically analyzes process liquids colorimetrically . . . performs *all* the steps of a manual analysis without an operator's attention.

This industrial process tool has been tested and proved in field installations . . . can be used to automate many colorimetric analyses not requiring filtration or boiling. Instruments for water analyses measure silica 0 to 0.05 PPM (parts per million), total hardness 0 to 3 PPM, iron 0 to 100 PPM, and phosphates.

Take a second look at these in-plant process instruments . . . see how they can be applied to your problem. Write for Bulletin 1156 on the Quantichem colorimetric analyzer . . . *Suncoast Instrument Division*, Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania. Engineering representatives throughout the world.

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CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
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tioning of the valves, positioning of the diaphragms, and the coördination between the two. Any one of these three can disrupt the entire meter operation, to result in erratic action and consequently high wear and poor meter performance over an extended period.

Testing Performance

A slope or draft gage mounted in conjunction with the proving equipment can be a valuable asset in determining meter operations. This instrument is used to measure the difference in pressure between the inlet and the outlet of the meter while it is on the prover.

Fluctuation of this differential pressure reflects the degree of unbalance, binds, or poor timing which is built into the gas meter. The gage will indicate very quickly any malfunctioning which has been built into the meter.

New Way to Figure Ventilation

By JOHN D. CONSTANCE

NEEDS for ventilation are dictated by the requirements of human comfort and safety. The Guide of the American Society of Heating and Air Conditioning Engineers and local and state codes spell out these requirements, but simplified methods of calculation have not appeared in the technical press.

In a few installations the heat generated by machinery and processing equipment may be readily calculated and the outside air quantities for ventilation from the standpoint of comfort may be determined from

$$\text{cfm} = \frac{Q}{1.08 \times \Delta t}$$

where cfm is air flow in cubic feet per minute through the fan system, Q is heat liberated by equipment and piping or machinery expressed in Btu per hour, and Δt is the arithmetic difference in temperature between outside and inside dry bulb.

However, in most cases calculating Q is too cumbersome, time-consuming, and impossible. The method of air changes has been used in normal practice, but the values recommended vary widely with no apparent consistency.

Experience with the usual equipment shows that both toxic and hazardous vapors and gases may be found in the atmosphere of processing buildings. Where the system is a closed one and normally safe, dilution by ventilation presents no problem. For such systems the suggested method may be applied. Under such conditions minimum escape of gases and volatile liquids can be tolerated. Air quantities determined by use of the accompanying graph would not be recommended where the system is not closed or abnormal conditions prevail, permitting escape of excessive quantities of toxic and explosive gases into the room. For these, local exhaust systems should be installed.

The second need for good ventilation is that affecting human comfort. Air flows found by using the usual equation set forth above are found to be excessive. In the method recommended, a more liberal viewpoint has been taken in establishing human comfort conditions and emphasis has been placed on obtaining "workable" temperatures at the breathing line (up to 8 ft above the floor line). Under these conditions air temperatures above 8 ft would rise above the comfort zone, but would have no bad effect.

By supplying outside air low around the periphery of the machine or compressor room while exhausting mechanically high in the roof or high in the outside walls, safe, comfortable conditions may be realized. For this design the chart shown here has proved most useful. Air flows so determined are summer requirements. A 50 per cent reduction or recirculation has been found to be acceptable.

Before using the graph, the following data are to be collected.

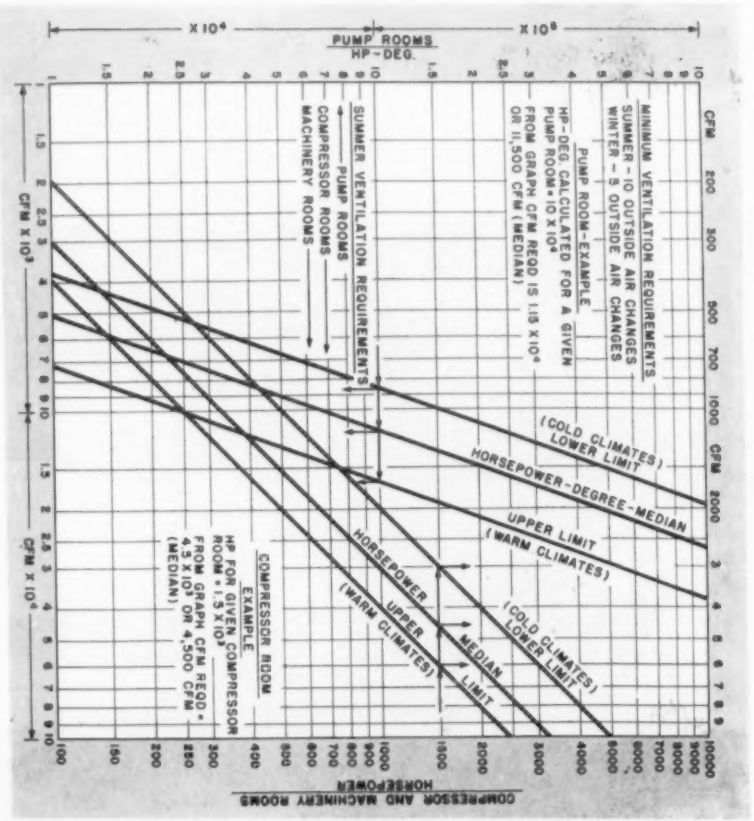
1. List equipment in the enclosure.
2. Obtain rated horsepower (electric motor or steam turbine) and pumping temperature.
3. If compressor, pick hp only.
4. Collect above data for each arrangement of pumps alone, compressors alone, or any combination thereof.
5. For each pump multiply rated driver hp by pumping temperature for which you get hp-deg.
6. Total hp-deg for all pumps and use graph to get ventilation air needs.
7. For compressors get summation of hp and refer to graph for air flow needs.
8. Select total fan capacity 10 per cent in excess of graph figures.

When both pumps and compressors are combined in the same room the air flows are additive.

Selected cfm's should not be less than the equivalent of 10 air changes based on gross room volume, with five for winter operation.

$$\text{Min per air change} = \frac{\text{Gross Room Volume (cubic feet)}}{\text{Selected cfm}}$$

$$\text{Air changes} = \frac{60}{\text{min per air change}}$$

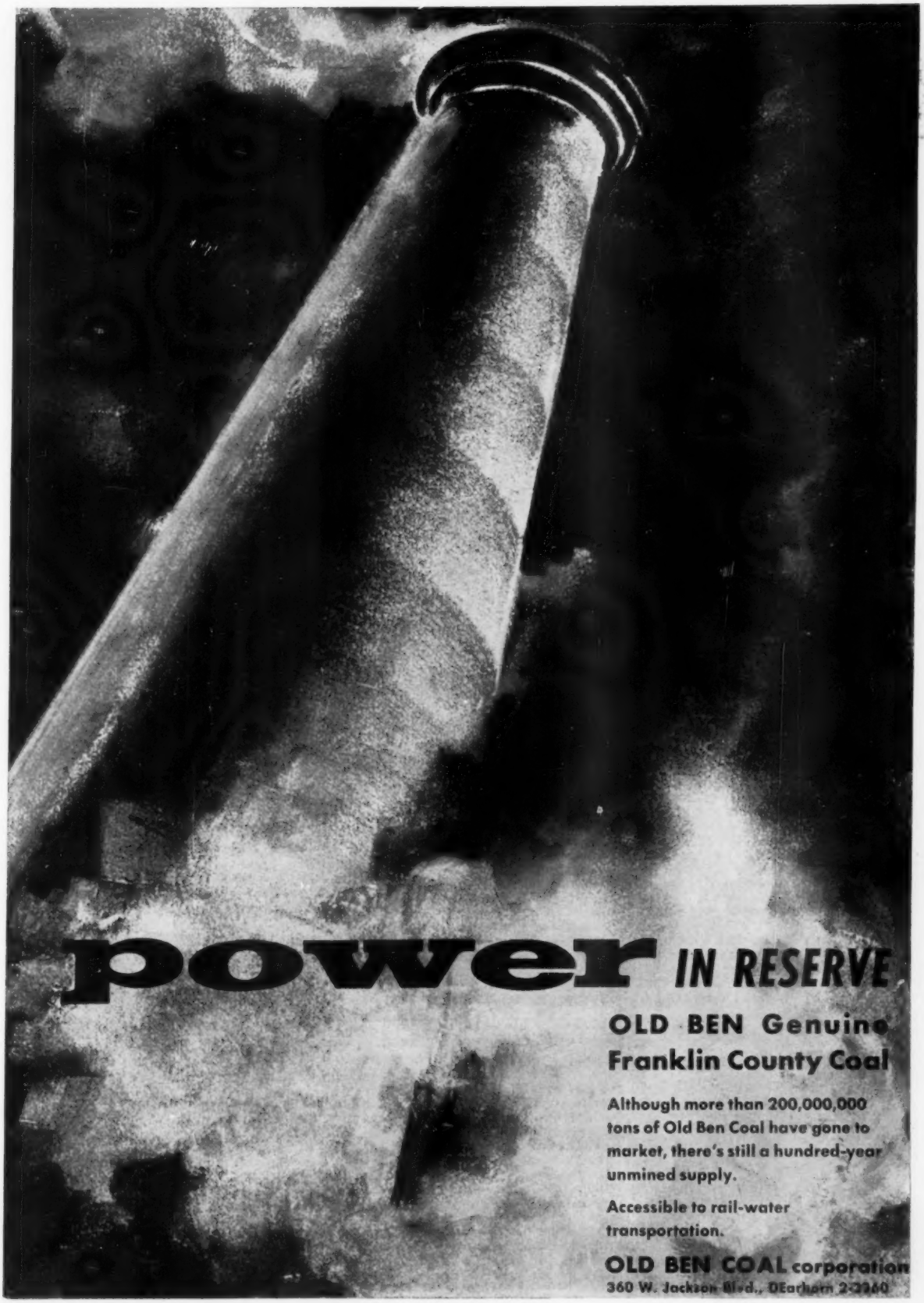

PUMP ROOMS
HP-DEG.
MACHINERY ROOMS
COMPRESSOR ROOMS
PUMP ROOMS
SUMMER VENTILATION REQUIREMENTS
FROM GRAPH CFM REQD IS 1.15 X 10⁴ OR 11,500 CFM (MEDIAN)
HP-DEG. CALCULATED FOR A GIVEN PUMP ROOM = 10 X 10⁴
PUMP ROOM—EXAMPLE
SUMMER—10 OUTSIDE AIR CHANGES
WINTER—5 OUTSIDE AIR CHANGES
MINIMUM VENTILATION REQUIREMENTS
CFM
(COLD CLIMATES) LOWER LIMIT
HORSEPOWER-DEGREE-MEDIAN
UPPER LIMIT (WARM CLIMATES)
HORSEPOWER
UPPER (WARM CLIMATES)
MEDIAN LIMIT
(COLD CLIMATES) LOWER LIMIT
HP FOR GIVEN COMPRESSOR ROOM = 1.5 X 10³
FROM GRAPH CFM REQD = 4.5 X 10³ OR 4,500 CFM (MEDIAN)
COMPRESSOR ROOM EXAMPLE
CFM X 10³
CFM X 10⁴
COMPRESSOR AND MACHINERY ROOMS HORSEPOWER

Using this graph does away with use of the air-change method of figuring ventilation needs for machinery rooms in a closed system, normally safe, where dilution by ventilation presents no problem

POWER ENGINEERING HANDBOOK

fold along this line—outside edges toward you

cut along this line


power IN RESERVE
OLD BEN Genuine
Franklin County Coal
Although more than 200,000,000 tons of Old Ben Coal have gone to market, there's still a hundred-year unmined supply.
Accessible to rail-water transportation.
OLD BEN COAL corporation
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For more data circle 534 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 105–106 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—BRICK GREASE for open-well top-feed bearings

No. 42 Brick Grease lubricates properly without either processing or frictional heat, manufacturer announces; it has a working range from 0 to 175 F and a melting point of 290 F. Its surface film is described as very oily and, when the brick is properly installed it is said to provide even, ample lubrication without waste. No. 42 Brick Grease is reported to maintain a perfect lubricating film on journals of ball, pebble and tube mills, in power and chemical plants; flour roller mills, and other open-well bearings in the same temperature range. In addition to improving lubrication by increasing bearing life and reducing power consumption, this high lubricity grease is claimed to eliminate drippage around machines, prevent oil damage to leather belts, and reduce quantity of lubricant used. Keystone Lubricating Co.

2—CIRCUIT BREAKER has spring operated closing mechanism

Principal design advancement in the AK-2-15 and the AK-2-25, low voltage power circuit breakers, is a spring operated closing mechanism for both electrical and manual breakers which provides "stored energy" closing of breaker contacts at a speed independent of operator. On electrical breakers, closing is provided even though control power should be lost during closing action, it is stated. Unit mechanism construction is designed to facilitate field conversion from manual to electric operation. Trip units are interchangeable for all ratings 1600 amp and below. General Electric Co.

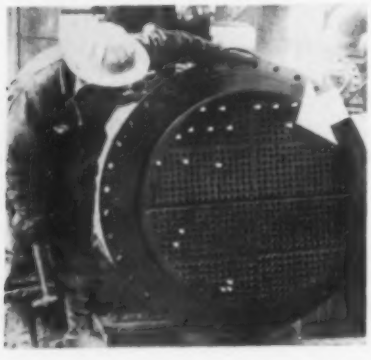
3—SUBMERSIBLE MOTORS for direct coupling to pumps

Designed for direct coupling to pumps which must operate continuously while submerged in oil, water or liquid chemicals, these polyphase, single-voltage submersible a-c electric motors are available in sizes from ¾ through 15 hp. Universal mounting flange is designed for direct connection to most standard pumps and modifications can be made to meet special requirements. Pump and motor assembly can be lowered into mounting position and attached as a single unit. Integrally cast rings at top edge of frame permit convenient, balanced handling. Rated at 55 C temperature rise for 30-min duty in 40 C air, and for continuous duty in 40 C liquid, the pressure-proof motors are oil-filled and are said to give long, trouble-free performance when immersed at any depth. Reliance Electric and Engineering Co.

4—STEAM METER compensates for pressure variations

Usefulness of this company's well-known Shuntflo-Meter has been extended by the addition of a pressure-compensating counter box. With this, the Shuntflo-Meter automatically and continuously corrects for pressure variations in the steam line, it is announced, registering consumption in pounds of steam even when major fluctuations are encountered. Basic design of the meter has not been altered by the pressure-compensating counter. With certain models of the meters now in service, the new feature can be obtained by replacing the standard counter box with a pressure-compensating one. The meter does not have to be removed from the line and neither special tools nor machining are required.

When purchased as a complete unit, the Shuntflo Meter comes ready for bolting into 1- to 12-in. steam lines. A small tube transmits pressure changes from the steam line to the pressure-compensating counter, where a compact bellows and integrating mechanism interprets these changes and produces steam-consumption readings with accuracy given as ±2 per cent. Bulletin 400-P3 gives data on this steam meter. Builders-Providence, Inc.

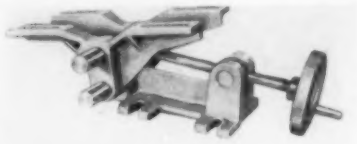


5—TUBE PLUGS for heat exchangers and condensers

These plugs are for sealing off corroded or leaking tubes in a heat exchanger or condenser so that the unit may continue to operate without entire tube bundle being replaced. An important design feature is a dome-shaped driving surface to assure concentricity in the tube even when struck a glancing blow and to virtually eliminate possibility of damage to the tube sheet. Their taper of 1 deg 47 min is optimum for sealing the tube and for preventing damage to either tube or tube sheet, company states. Plugs are available in a variety of materials in sizes for use with tubes of ½- to 1½-in. diam. Nuclear Products Co.

6—TILTING MOTOR BASE provides proper belt tension

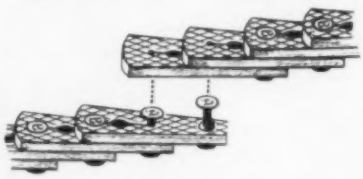
This low-cost tilting motor base is designed to provide correct belt tensioning at all times for electric motor driven applications ranging from 1 to 3 hp. It



is especially designed for use with variable speed pulleys and permits easy belt changing on cone step pulleys. Speed control is maintained by means of a hand screw adjustment. The motor base fits both new and old NEMA frame sizes. It is simply constructed, rugged and compact, requires minimum space and can be mounted in any position. Actual size is 9⅝ by 20¼ in. Lovejoy Flexible Coupling Co.

7—SECTIONAL V-BELT adjusts to any length V-drive

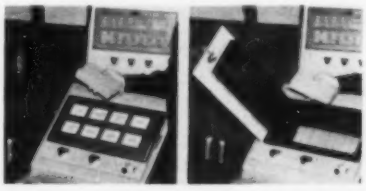
Dixlink is a sectional-type V-belt, designed for quick and easy installation on V-drives of any length. Dixlink is made



in oil-resistant, heat-resistant and fire-resistant grades, as well as in the regular grade for general use. Dixlink is reported particularly fast and simple for installations where an endless unit is not suitable due to structural restrictions or fixed centers. It is available for V-belt drives of from ½ to 1000 hp. R & J Dick Co.

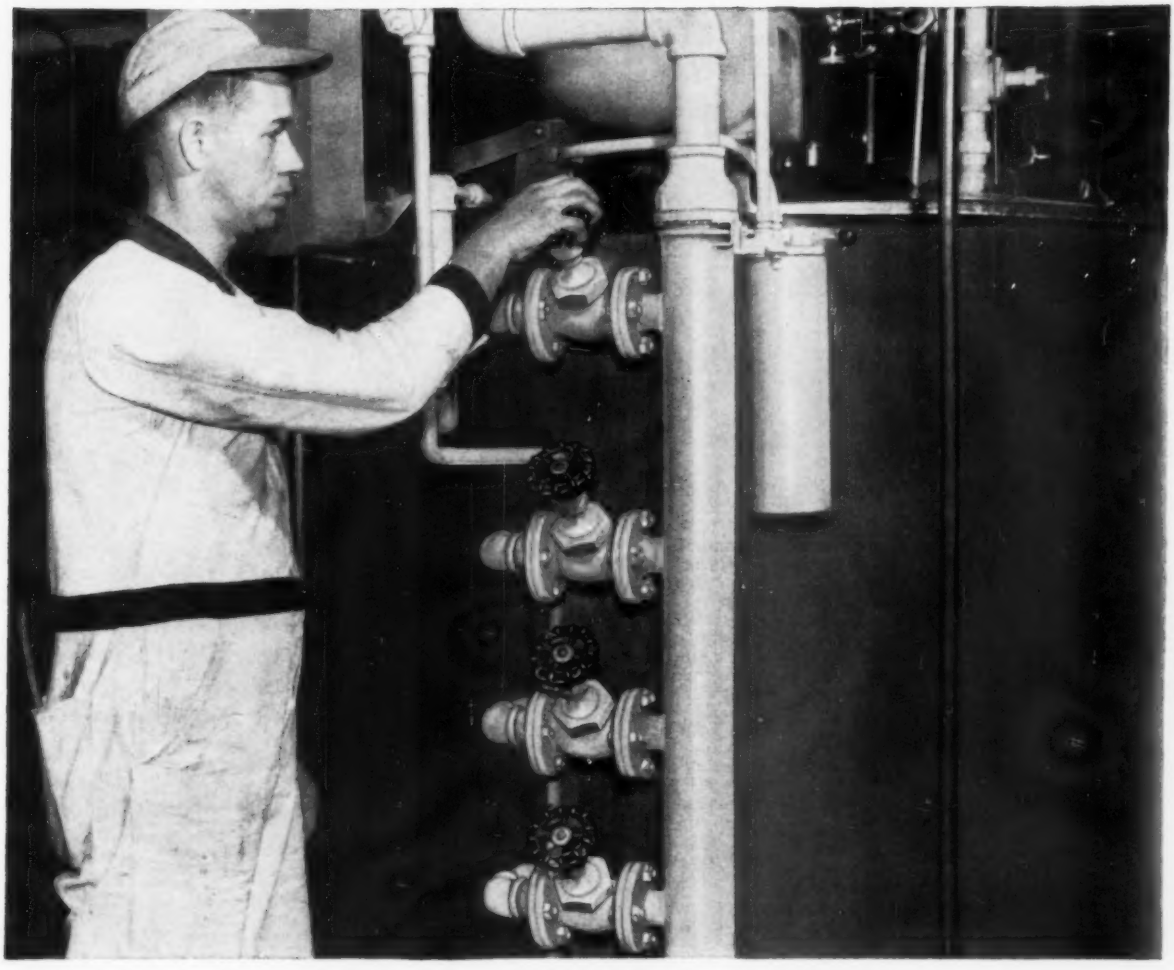
8—ANNUNCIATOR monitors complex systems without relays

This annunciator for monitoring complex automatic systems uses static-magnetic controls instead of the precision relays used in company's conventional annunciator. It reports "off-normal"



occurrences on an instrument type panel by both visual and audible means. Annunciator controls have no moving parts and are said to provide a high degree of reliability for monitoring critical operations or conditions. Plug-in design of the static-magnetic elements makes it possible to change sequences without rewiring, or to expand annunciator system as required. The annunciator's static-magnetic elements are capable of the logic functions: AND, NOT, OR and MEMORY. A "retentive" memory circuit can be included; in case

How Cincinnati Plant Stops Valve Maintenance Problem



CRANE Valves End Excessive Shutdowns for Repairs

About every four months maintenance men of Sealtest, Central Division, Cincinnati, Ohio, had to replace worn, leaky discs and thread-stripped stems of valves used on the dairy's pasteurizing tanks.

The high cost of down time, labor and parts was only a part of this maintenance problem. Each time the valves had to be repaired, the dairy suffered a drop in production and faced the possible loss of 600 gallons of milk.

Upon recommendation, Crane No. 9 bronze globe valves, with quick-change composition disc, were installed. Today—two and one-half years later—these Crane valves, opened and closed a dozen times a day, have not cost the dairy one cent for repairs, or any loss in production or milk.

Here again is proof that Crane valve economy is never measurable in terms of first cost. You get it in years of maintenance-free service.

That's why more prudent buyers specify Crane valves for every service.

LEARN WHY Crane bronze valves with composition discs are so economical for service on steam, hot or cold water, oil or gas. Write to address below for Circular AD-2222.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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of power failure, it "remembers" its previous state after power has been restored. The static-magnetic annunciator is declared particularly applicable to systems where interlock or automatic shutdown are involved. Panellit, Inc.

9—CONTROL TRANSFORMER *can use any standard raceway*

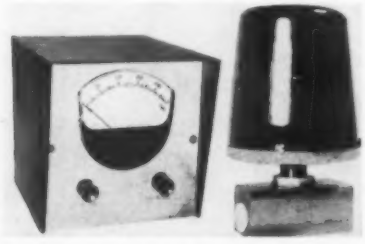
The Condutran is a control transformer so designed that any standard raceway can be attached directly to it by means of a suitable conduit fitting securely fastened into transformer housing. It is planned to equip any of the standard transformers in company's line with these electrical conduit and cable fittings. These will include standard fittings, couplings, insulated connectors as well as the regular female threaded hubs for use with liquid type flexible conduit, rigid conduit, portable cord, buss drop cord (sheated cable). E.M.T., and interlocked armored cable. These will be available for conduit sizes up to and including 1 in. Hindle Transformer Co.

10—ALARM SYSTEM has integral flashing feature

Electro-Pane annunciator units now offer an integral flashing feature in each plug-in unit. According to company, it can provide individual flashing at each station, eliminating flasher failure causing a number of alarm stations to malfunction. The new units are not factory sealed, yet have mercury switches and can be completely disassembled in field for inspection and preventative maintenance. Electro Devices Inc.

11—METERING UNIT gives remote indication of variables

Low cost, remote indication of flow rate, speed or position is the function of the Metertrol. When used with company's Shaftrol (shaft-mounted gearmotor), the Metertrol provides remote or automatic control for valves, variable speed drives and other machinery A potentiometer built into the Shaftrol provides the position indication registered on the Metertrol. It may also be used with



other positioning devices incorporating or driving a potentiometer.

The Metertrol provides indication by a milliameter calibrated from 0 to 100 with a linear response to valve or drive setting, and is said to provide full accuracy all the way to zero setting. The unit includes control pushbuttons, indicating meter and a ratio adjusting knob under the hinged front panel. The knob enables obtaining full-scale meter deflection for as little as 1/10 of full movement of the positioning device without sacrifice of linearity, it is noted. Standard Metertrols come in NEMA 1 enclosure for panel or base mounting. Data in Bulletin J-101. The Jordan Co., Inc.

12—IMPROVED VENTURI gives higher pressure differential

The Twin-Throat Venturi is designed to produce higher differential pressure or lower head loss in a much shorter laying length. Applications include metering of water, sewage, air and other fluids and gases. The unit (shown at right, with conventional type) is basically simple in

principle. Low pressure is taken from a hydraulically-streamlined body instead of from a wall. This body is placed in the center of the narrowest cross-section, at a point at which the pressure is further lowered by the locally increased velocities around it. By such arrangement a higher differential is obtained without materially changing the energy conversion in the tube, while the head loss remains practically the same. Thus, by selecting a proper area ratio, the larger differential is obtained without increasing the loss. By choosing a larger area ratio, the head loss is smaller. Details are in Bulletin 1021. Infilco Inc.

13—TEMPLATE *contains mathematical symbols*

The No. 17 Template contains all mathematical symbols and includes the small letters of the Greek alphabet, parentheses, brackets, root symbols and integrals of varying size, numerals and some of the capital Greek letters used in mathematical and chemical formulae. Made of 0.030 mathematical quality plastic, its overall size is 6 ¼ by 2 ½ in., and price is about $3. RapiDesign, Inc.

14—ENCLOSED D-C MOTORS for contaminated atmospheres

Totally-enclosed motors with self-contained heat exchanger cooling for operation in highly contaminated atmospheres are offered in constant or adjustable speeds in frame sizes of EB-120 and up and in ratings from 10 through 200 hp. They are designed for machine tool, steel mill drive, paper mill applications and other locations having airborne foreign matter. According to manufacturer, the motor's independent cooling system is unaffected by speed of motor and a thermostatic relay in the hot air stream at the commutator end shuts down the drive or operates an alarm in case of blower power failure.

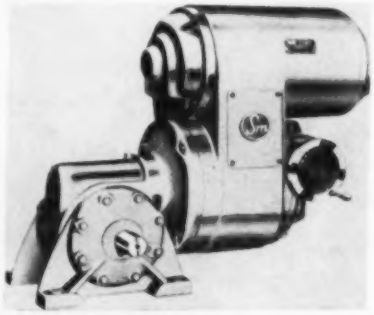
Wiring and inspection are simplified by separate conduit boxes for the d-c motor and the heat exchanger unit. Filters, which can be cleaned during routine maintenance, sift impurities from the outside air entering the heat exchanger. Available as a unit the d-c motor heat exchanger combination is constructed so as to allow top, sidewall or ceiling mounting, and the self-contained heat exchanger unit can be removed for maintenance. Design features are given in Bulletin 53B8904. Allis-Chalmers Mfg. Co.

15—CABLE TROUGH in lightweight expanded aluminum

This expanded aluminum cable supporting system includes a wide range of standard fittings to provide simplicity, flexibility and low cost in installation. Among advantages claimed for aluminum cable trough is its light weight, which reduces installation costs as entire sections may be lifted into place after assembly and awkward spaces are reached more easily, and its resistance to many corrosive atmospheres. The aluminum trough is manufactured with solid sides for greater strength. Sections are secured by flat pins driven between interlocking barrels. Straight lengths are available in widths of 6, 9, 12, 18, and 24 in. and in 8-, 10-, and 12-ft lengths. T. J. Cope Div., Rome Cable Corp.

16—VARIABLE SPEED DRIVE with right angle gears

The Speed-Trol Variable Speed Drive integrally combined with a right angle gear reducer is claimed ideally suited for variable speed applications where the output shaft must be at right angles to the transmission, due to space limita-



tions and/or application requirements. The Speed-Trol with its positive pulley construction, is designed to provide infinitely variable speed and accurate maintenance of speed, while the right angle gears transmit power smoothly and quietly. Positive oil seals are used on both input and output shaft of reducer portion, to permit units to be operated horizontally or vertically, shaft up or down, without danger of oil leakage. Motors with right angle gears are available in drip-proof and totally-enclosed construction, in speeds from 360 to 5.5 rpm, and speed variations from 2:1 to 10:1. Sterling Electric Motors, Inc.

17—STRIPPER gets the cable sheath off faster

To simplify the job of stripping sheath from all sizes of plastic and fabric covered cable, this tool consists of a red rigid phenolic handle having a razor blade protected with an L-shaped guard. A stainless steel saddle holds guide and blade in place. The saddle is secured to the handle by a pair of screw bushings and screws, and an auxiliary groove in the handle supports and guides the cable. The handle is shaped to protect

what's your plant water problem?

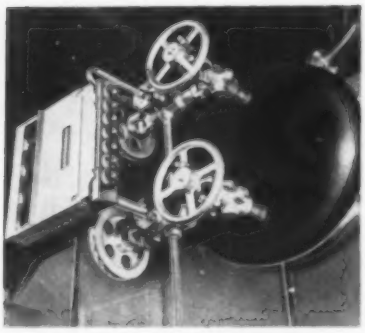
■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

BETZ LABORATORIES, INC., Philadelphia 24, Pa.

the user's hand and the shape of the guide serves to protect the enclosed wires from damage while slitting sheath. Operation is simple — you hold the stripper in one hand and guide the cable with the other. Two extra blades are carried in slot in the handle. The tool costs less than $8.00. P. K. Neuses, Inc.

18—GAGE ASSEMBLY needs only two welds to install

The Double-Safe Gage Package is shipped as a fully welded assembly requiring only two field welds to the drum connections for installation. Shutoff valves of the locking type are provided in series with the gage valves to meet the trend to the use of double valves on boiler gages.



Available for 21- and 27-in. center-to-center of boiler connections in both integral tie bar and support tube construction, for parallel or normal viewing, this assembly is designed to meet requirement of almost any installation. The assembly is available with multi-port (or continuous vision gage) for operating pressures above 900 psi. The bi-color principle invariably shows steam red and water green. The multi-port construction has small round ports. The gage is not removed from the boiler for gasket changes or other normal maintenance. Diamond Power Specialty Corp.

19—GATE VALVES, of forged steel, compact design

These forged steel gate valves are compactly built for easy installation in cramped quarters. Featuring the bolted bonnet design, with outside-screw rising stem, solid-wedge disc and rolled-in seat rings, the valves are available with screwed or socket welding ends in ½- through 2-in. sizes. They are rated 800 lb at 850 F, and 2000 lb at 100 F. The Lunkenheimer Co.

20—ACID REGENERATOR for demineralizing equipment

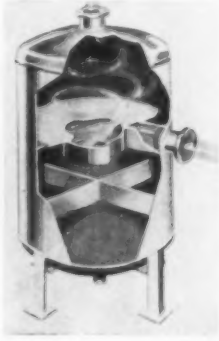
Available, where required, is a progressive acid-regeneration system designed to automatically increase acid regenerant concentration to the cation units of this manufacturer's demineralizers at prescribed rates in an infinite number of steps. According to company, this system is desirable when full optimum cation-exchange performance characteristics and reproducible results with minimum operation supervision are desired. It is explained that normally, cation exchange resins are regenerated with sulfuric acid of specific concentrations. However, on certain water supplies there is danger of forming inhibited calcium sulfate precipitates during regeneration and precautions must be taken. One method of regeneration is the step-rinse "gradient" or "ascending" acid regeneration system that increases the prescribed rates in an infinite number of steps. Major controls for this automatic progressive system consist of a transmitter to measure the acid flow, a control valve to control the flow, a flow controller to control the valve and a program regulator cam to operate the variation of flow as required. Graver Water Conditioning Co.

21—COMPRESSOR REGULATOR maintains constant pressure

The Technomatic Air Compressor Regulator is a device for controlling the operation of air compressors when such compressors are equipped with suction unloading valves. It differs from other types of compressor regulators in that it maintains constant pressure on the receiver at all times regardless of load. Regulator is connected to the air receiver and another connection is made to the suction unloading valves. By varying opening of unloading valves the compressor never operates in the "unloaded" condition. Regulator maintains a constant pressure on receiver regardless of the variations in loads being carried and, according to company, is guaranteed to maintain receiver pressure within plus or minus one per cent. With the regulator the compressor runs constantly and responds to load demands quickly without any change in receiver pressure. Techno Corp.

22—SAND SEPARATOR removes sand, silt from water

Boasting sand removal efficiencies close to 100 per cent, this sand separator is designed for use by food processing and chemical industries, and municipal systems requiring automatic valving, and other hydraulic components subject to fouling from small sand or silt particles. The separator uses a two chamber system — one to separate heavier particles through a centrifugal-helical action utilizing water at high velocity, and one to separate residual fine particles



by reducing water velocity below "fall out" velocity of fine particles. According to company, virtually complete sand removal is attained with little pressure drop (2 to 4 psi), and large gpm fluctuations have no effect on efficiency.

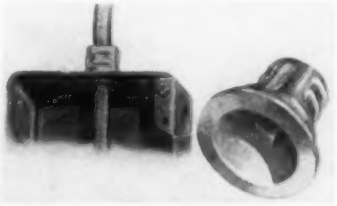
Sand-laden water enters a volute which forces it into a helical-centrifugal path while increasing its velocity. Solid particles are forced to outer periphery of volute where they are allowed to escape into the settling area. Sand-free water continues upwards in its helical path toward the outlet. As velocities are slowed, any residual particles gravitate to a dividing plate where they are washed outward and down into the settling area through a slot at the edge. Accumulated sand can be discharged (usually two to three weeks) through a bottom control valve. Walter R. Cole & Co.

23—CONTROL PACKAGE for electric heat unit ventilators

This control package may be applied to any conventional classroom type electric heat unit ventilator. Its positive-acting step control eliminates need for variable voltage regulators and magnetic contactors in the control of electrical input to the heating elements, manufacturer notes. The pre-wired package consists of a dual element thermostat which provides control of both room and discharge air, an electric motor operator to position heater control switches and outdoor and return air dampes to provide standard ASHAE unit ventilator control cycle Y and a step controller for control of heaters. Data Sheet F 8705 gives engineering information. Barber-Colman Co.

24—CONNECTOR is one-piece for fast and easy installation

The Pres-Sure Romex connector is designed for fast and easy installation on non-metallic sheathed cables, portable cords, etc. Made in one piece of heavy duty aluminum alloy, it requires no



screws or lock nut. The ¾-in. trade size, connects or fits standard 1½-in. knockouts. To install, merely insert cable in junction box knockout. Slide connector over cable and squeeze with channel-lock type pliers or side cutters; this simultaneously locks connector to cable and to the box. To remove, just squeeze opposite sides of connector and cable is released. Connectors are announced as UL approved for 14/2, 14/3, 12/2, 12/3 and 10/2 non-metallic sheathed cable. Buchanan Electric Products Corp.

25—CENTRIFUGAL PUMP for horizontal or vertical use

Type A5 Centrifugal Pump is of the volute type and designed for horizontal or vertical installation. It can be used as a circulator in a hot-water system, chilled water air conditioning system, or in a cooling tower installation. Typical supply system applications include boiler feed, processing, drainage, washer service and booster service. The pumps can also be used as circulators in evaporative condensers. Motor of this pump incorporates ball-bearing dripproof frame with conduit box for easy connection, and screwdriver "holding" slot in shaft end opposite the centrifugal pump. Shaft and mounting flange comply with

ANOTHER NEW LESLIE PRODUCT

ADJUSTABLE PROPORTIONAL BAND Floatless LIQUID LEVEL CONTROL

...with adjustable level ranges up to 0-200"

Here is a new differential pressure-type liquid level control pilot that combines the wide adjustable level ranges in the table shown below with a 2-20" or 7-25" adjustable proportional band.

ADJUSTABLE LEVEL RANGE — INCHES	ADJUSTABLE PROPORTIONAL BAND (INCHES, H_2O)	CONTROL PILOT TYPE
0-40 or 0-87	2-20	LAP
0-30 or 0-91	2-20	LABP
0-200	7-25	LAUP

Maximum Static Pressure — 300 psi

One Knob — Easy Adjustment

A single knob adjustment quickly sets the proportional band where you want it, even while the system is in operation. The liquid level is maintained constantly within that band until you re-set the control pilot for new conditions.

Applications

Leslie-Level-Matic Control Pilots are used in either open or pressurized vessels to control the level of virtually any liquid including water, gasoline, oil and chemical solutions. The new control pilot is particularly useful to maintain constant levels where there are high flow rates through vessels with small cross sectional areas.

Float Cages Eliminated

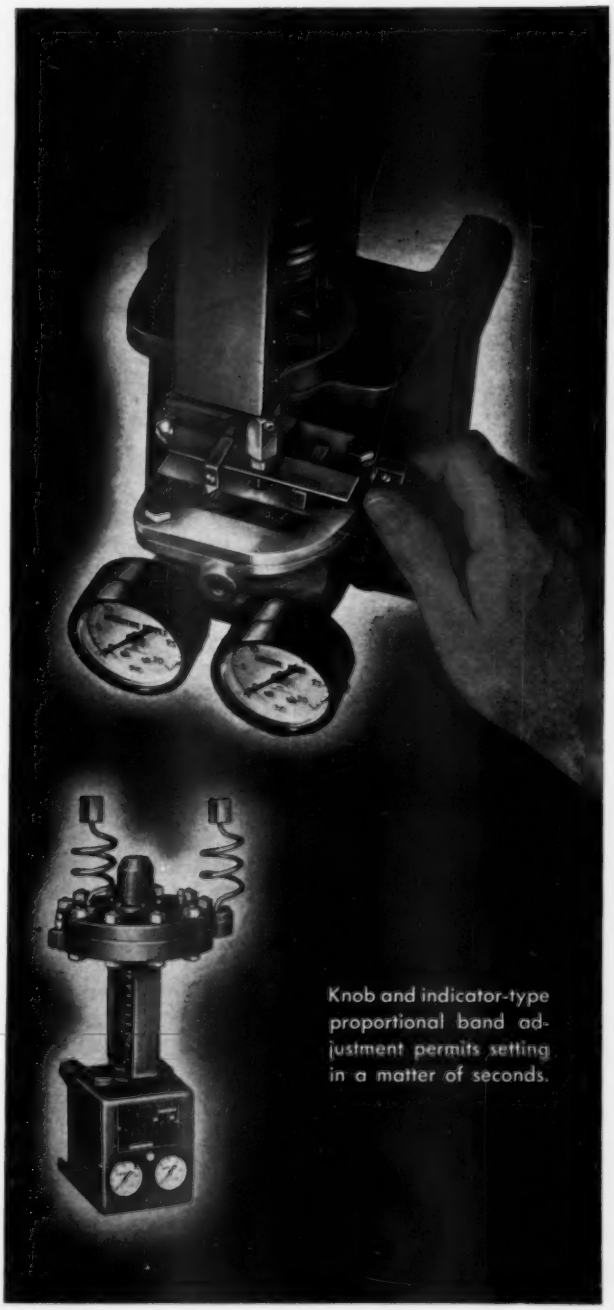
There are no floats or cages needed for Leslie-Level-Matic Control Pilots, and no torque tube seals, stuffing boxes, or thermohydraulic systems. All of the primary control elements are in one place and may be installed with a fraction of the effort and cost required for displacement-type controllers.

Vibration-Proof, Dependable

All of the dependability factors for which Leslie products are so well-known are incorporated in this new control pilot, as well. Rugged, accurate, stable — it is unaffected by normal vibration or turbulence.

More Information

Send for Engineering Data Sheet describing this new Control Pilot and outlining its principle of operation.



Knob and indicator-type proportional band adjustment permits setting in a matter of seconds.

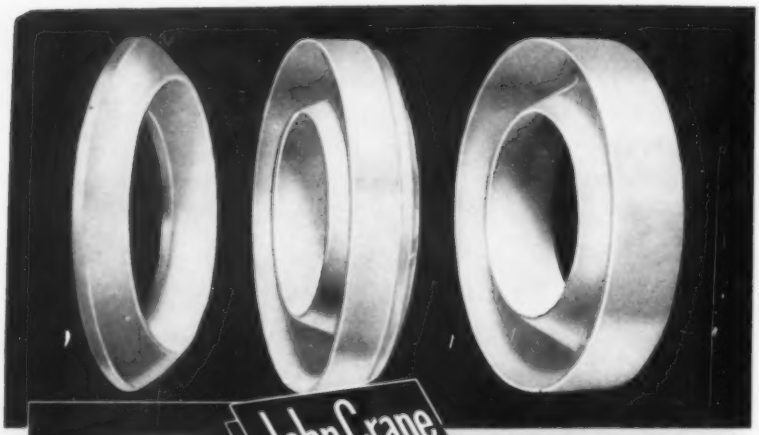
LESLIE

674

REGULATORS and CONTROLLERS

LESLIE CO., 301 Grant Avenue, Lyndhurst, New Jersey

For more data circle 537 on Post Card



John Crane

CHEMLON *

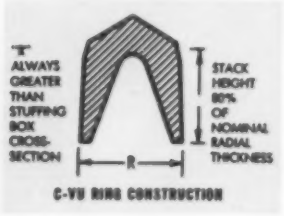
C-V RINGS

ARE INDUSTRY'S MOST UNIVERSAL PACKING . . .

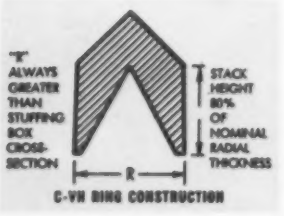
Countless successful applications of C-V Rings under the most severe service conditions have made this the closest approach to a universal packing.

It will effectively handle all industrial acids, alkalis, solvents, organic and hydraulic fluids . . . temperatures from −120°F. to +500°F. . . . is equally suited to valves, pumps, mixers, hydraulic cylinders and like equipment.

"John Crane" C-V Rings have extremely low coefficient of friction. "Breakout" friction is only slightly higher than running friction.



C-VU RING CONSTRUCTION



C-VH RING CONSTRUCTION

TWO STYLES ARE AVAILABLE:

C-VU RINGS *for low pressure service* —such as control and regulator valves handling gases and fluids, where it is necessary to have a very sensitive and resilient type packing.

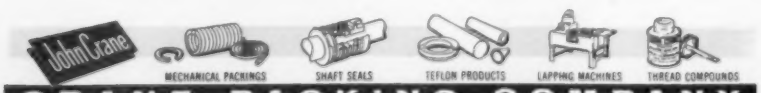
C-VH RINGS *for high pressure service* —for use in pumps, hydraulic cylinders and like services at pressures ranging to 500 psi. and over. These rings are constructed with a heavy wall heel to withstand pressure requirements. They are designed to provide voids between rings, so that as the Teflon expands due to heat, this take-up room minimizes any excess friction in the stuffing box.

"John Crane" C-V Rings are available in full line of standard sizes and male and female adaptors. Sizes can be molded to stuffing box specifications.

Request Bulletin P-325.

*"John Crane" C-V Rings are made from Chemlon—*the best in DuPont Teflon.*

Crane Packing Co., 6429 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



CRANE PACKING COMPANY

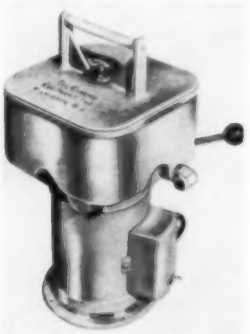
For more data circle 538 on Post Card

NEMA standards, it is noted, permitting interchangeability. The electrical system includes dual voltage, 115/230 single phase, 60 cycle with built-in thermal overload protection. For three phase, 60 cycle 208/220/440 is furnished. Thirteen sizes are offered in the range ⅓ to 2 hp, capacities to 150 gpm. File 1440 gives data. Dunham-Bush, Inc.

Reader Service Cards on pages 105–106 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

26—MOTOR PUMP is small, portable hydraulic unit

This small, portable hydraulic motor pump is designed to develop up to 10,000 psi pressure and weighs only 65 lb. Besides being used with hydraulic pipe benders, pipe pushers, knock-out punches, hydraulic jacks of any kind,



it can be readily installed and adapted to give fast, continuous power to existing equipment: for pressing, pushing or pulling bushings, bearings, shafts, pump pistons, arbor presses, lifting operations, pre-stressing of conduit, for any hydraulic repair tools, and wherever hydraulic power is used or can be used to replace mechanical power. The pump is rated for 10,000 psi intermittent and 5,000 psi continued duty delivering 80 cu in. of oil per minute and is driven by a standard ½ hp single phase, 60 cycle, 1,750 rpm 110–200 v motor. Tal Bending Equipment, Inc.

27—TORQUE CONTROL UNIT for controlled tube rolling

Low initial cost and adaptability to available air or electric tube rolling motors are features announced for the Expand-O-Trol, a mechanical self-contained torque control unit. It is priced to be bought as a maintenance tool. The Expand-O-Trol measures tightness of expanded tube joints by utilizing the torque resistance of the expanding tube, it is explained, resulting in uniformly rolled tube joints within the tube bundle. Risk of tube sheet warpage is claimed minimized and tube joint failure decreased.

The Expand-O-Trol consists of few parts, reducing maintenance, and through compactness the size-weight ratio is minimized. Its design incorporates a

NO PIPE DREAM HERE

It's a power engineer's nightmare instead. Each of the pipe specimens shown here had to be replaced. The cost of the particular nipple or elbow was minor. However, the cost of down time and replacement was expensive, indeed. And the cause in every case was either inadequate or incorrect water treatment.

A Consulting Service for You. Whatever your water problems...analysis, testing or treatment procedures for boiler water, condensate, cooling towers, process waters...Dearborn has the engineers, the experience and the laboratory facilities to assist you in developing the program exactly suited to your needs. Your Dearborn Engineer will outline the many advantages a Dearborn Consulting Service Program will give you.

WHY NOT CALL HIM IN... **MEANWHILE, MAIL THE COUPON FOR YOUR COPY OF THE DEARBORN CONSULTING SERVICE BOOKLET**

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...the leader in water conditioning and corrosion control since 1887

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For more data circle 539 on Post Card

"We can't take a chance on long costly maintenance ...that's why we use AIRETOOL equipment."

Why let excessive power equipment maintenance rob your production and profits?

With Airetool tubular maintenance tools on the job you can rest assured that regular maintenance or emergency repairs will be carried out quickly and effectively. And equipment will be restored to full operating efficiency.

Dependability of Airetool equipment has been proven in plants everywhere under all kinds of conditions. Make Airetool a part of your tube maintenance program right away.

Powerful air, steam and water driven motors with a full range of cleaning heads for every condition and for straight or curved tubes ¼" to 24" I.D.

Outside mounted condenser cleaners with built-in flushing system in lightweight and heavy gear drive models.

Air or electric driven positive feed internal tube cutters for quick removal of steel or non-ferrous tubes.

New Airetrol, pneumatic operated tube expansion control and electric operated expansion control systems.

Complete line of accessories for every tubular maintenance need.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

REPRESENTATIVES: in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.
CANADIAN PLANT: 37 Spalding Drive, Brantford Ontario.
EUROPEAN PLANT: Vlaardingen, The Netherlands.
BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.

For more data circle 540 on Post Card

"slip-clutch" with a friction wear compensating arrangement. When the desired torque is reached, the metallic-embedded fiber disc slips against the mating steel hub to discontinue further expansion. A simple dial setting is all that's required to increase or decrease torque values, it is pointed out, and production is stepped up because complete jobs can be rolled to the degree of tightness set. The Expand-O-Trol develops up to 25 ft-lb torque. It may be hand operated when only a few tubes are rolled. The Gustav Wiedeke Co.

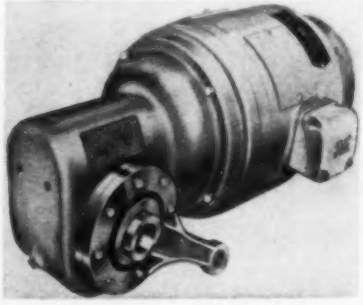
28—AIR FILTER is compact, automatic dry type

For use as a simple attachment for all types and models of air handling units, Far Air Roll-Kleen Type H Filter has a heavy gage metal frame which holds a large replaceable roll of glass fiber filter-

ing media and a power driven take-up spool. Electrical controls govern automatic movement of media across the face of the filtering area. According to manufacturer, the filter incorporates basic design features of the standard Roll-Kleen automatic filter with modifications and refinements required for operation as integral section of an air handling unit. Advantages cited include high or low velocity, high efficiency, large dirt holding capacity, low maintenance and a large filtering area in proportion to unit's overall size. Farr Co.

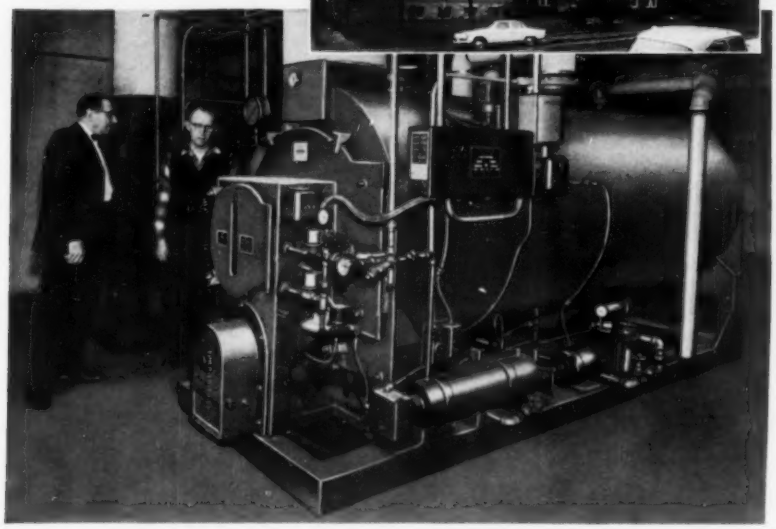
29—MOTOR REDUCER can be direct coupled to equipment

This right-angle worm Motoreducer features a hollow shaft that permits direct-coupling to equipment merely by inserting the drive shaft of a machine. No other mounting arrangement is required, except the torque arm which serves as a



simple "anchor" for the Motoreducer. According to manufacturer, the unit can be mounted in extremely limited spaces and in almost any conceivable position: side, overhead, vertical, shaft up or down. The units are available with standard single-speed motors, or in "power packages" including magnetic brakes, slip ring, two-speed and fluid shaft drive motors. Horsepower range is ½ to 2, with 13 gear reduction ratios from 18 to 250 rpm. Reuland Electric Co.

Two 75 H.P. Continental Automatic Boilers at Gordon Junior High School, Coatesville, Pa. Theodore Stetler (right) superintendent of maintenance shown with Merrill A. Squier, of Besco Sales, Continental Boiler representative.



HEATING COSTS CUT 21% with new Continental Boilers

In 1955, the Coatesville, Pa. school district purchased two new 75 H.P. Continental Automatic Boilers firing #5 oil to heat three adjoining school buildings from a central plant. The new boilers saved $2,614.51 in the first two years of operation. This is a 21% reduction in heating costs.

Merrill A. Squier, of Besco Sales, Continental Boiler representative in the Philadelphia area, says:

"You can count on Continental for highly efficient, low cost steam or hot water. Because of the simplified design, maintenance and downtime are cut to the bone. There are no refractory baffles to burn out, leak and cause short circuit of gases. Free rapid water circulation keeps heating surfaces clean. Steam and water spaces are easily checked through openings. Clean-out is easy."

Continental Boilers, firing oil or gas, are available in models from 20 to 600 H.P. with on/off, low-high-low, or modulating controls. For steam heating or process work at pressures from 15 to 250 lbs., or hot water heating at low or high temperatures. Literature on request.

BOILER ENGINEERING & SUPPLY COMPANY, INC.
Phoenixville, Penna.

The Continental AUTOMATIC BOILER

A HALF CENTURY OF BOILER MANUFACTURING EXPERIENCE

Let your Continental Automatic Boiler Specialist Help You

CALIFORNIA
El Cerrito—American Engineering & Mfg. Corp.
Palm Springs—Pacific Engineering Equip. Co.

COLORADO
Englewood—Champion Specialty Co.

DISTRICT OF COLUMBIA
Washington—Charles C. Plummer

FLORIDA
Jacksonville—H. L. McMurry & Co.
Miami—H. L. McMurry & Co.
Orlando—H. L. McMurry & Co.
Tampa—H. L. McMurry & Co.

GEORGIA
Atlanta—Mechanical Associates
Augusta—Tarte Boiler Repair Co.

ILLINOIS
Chicago—Automatic Steam Sales Co.

INDIANA
Indianapolis—Plibrico Sales & Service Co.
New Albany—Falls Cities Boiler & Machine

LOUISIANA
New Orleans—Cressy Sales Company

MARYLAND
Baltimore—Heating Services, Inc.

MASSACHUSETTS
Dorchester—Lewis National Corp.

MICHIGAN
Dearborn—Kramer & Associates, Inc.

MINNESOTA
Minneapolis—Oil Burner Service Co., Inc.
St. Paul—Lincoln Equipment Company

MISSISSIPPI
Jackson—Climate Engineers, Inc.

MISSOURI
St. Louis—Continental Boiler & Sheet Iron Works

NEBRASKA
Omaha—Midwest Utility Service Co., Inc.

NEW YORK
Buffalo—W. J. Clark Equipment Co.
Gloversville—Olin T. Caldwell & Co.
Hudson Falls—Boiler Equipment Co.
New York—Thermal International, Inc.
Rochester—Ernest J. Rookey
Syracuse—U & S Supply Corp.

NORTH CAROLINA
Greensboro—M. G. Newell Co., Inc.

OHIO
Cincinnati—Kenneth B. Little Co.
Cleveland—P. M. Equipment Co.
Toledo—Air Conditioning Distributors, Inc.

OKLAHOMA
Oklahoma City—Mecha-Line Co.

PENNSYLVANIA
Phoenixville—Besco Sales, Merrill A. Squier
Pittsburgh—John C. Gregg Company

RHODE ISLAND
Providence—Weatherall Engineers, Inc.

TENNESSEE
Knoxville—Boiler Supply Co.
Memphis—Middle States Associates, Inc.
Nashville—Boiler Supply Company

TEXAS
Dallas—Rodgers Engineering Co., Inc.
Fort Worth—J. P. Philibert

UTAH
Salt Lake City—Power Engineering Company

VIRGINIA
Suffolk—C. Fred Bailey

WISCONSIN
Milwaukee—Industrial Steam, Inc.

For more data circle 541 on Post Card

WHEN YOU INSTALL

GOODALL *Rubber* EXPANSION JOINTS

LOWER INSTALLATION COSTS...

Goodall Rubber Expansion Joints are easier to install on new construction or as replacements. They are light in weight, with short face-to-face dimensions. Retaining rings or flanges are quickly aligned and bolted. No gaskets are required. The installation takes less time ... at a saving.

LONGER SERVICE LIFE...

Goodall Rubber Expansion Joints last longer in service because of inherent characteristics of the material from which they are made. There is *no embrittlement* ... continuous movement (flexing) actually keeps the rubber joint "alive". There is no corrosion or electrolysis. Resistance to abrasion is exceptionally high. Replacement costs are lower.

• • •

With Goodall Rubber Expansion Joints only the slightest pressure is required to create movement in any direction. Result—stress on metal pipe or other member is reduced to an absolute minimum. All styles are available in sizes from ⅜" to 96" I.D., for pressures up to 125 lbs. P.S.I. (depending on size) and/or vacuum.

"If it's GOODALL, it MUST be GOOD!"

Write for Literature or Contact Our Nearest Branch

Standard of Quality—Since 1870

HOSE • BELTING • FOOTWEAR • CLOTHING AND OTHER INDUSTRIAL RUBBER PRODUCTS

GOODALL *Rubber Company*

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

BRANCHES AND DISTRIBUTORS THROUGHOUT THE UNITED STATES. IN CANADA: GOODALL RUBBER CO. OF CANADA LTD., TORONTO.

For more data circle 542 on Post Card

Burning Pulverized Coal

continued from page 71

Dr. Godfrey W. Himus, Professor of Fuel Technology at the Imperial College of Science and Technology, London, England, makes the observation that coals with high coking index tend to give aggregates of adhering particles in the furnace, whereby the effect of fine grinding is offset and the loss of unburned carbon is increased. If the swelling is unaccompanied by caking, then carbon losses may increase because the increased volume of the particles makes them more liable to be carried in suspension across the furnace. Thus it would appear that the available effective reactive surface is lessened by a shield of slow-reacting surface, and that for general use a coal in the mid-range of the free swelling index would prove most desirable.

Handling and Uniform Feeding

Handling of the coal between the point of storage (or unloading the railroad cars) and the pulverizing mills, normally may be done by any one of the several types of conveyors. Types of conveyors and elevators in common usage are belt, flight or scraper, bucket, screw, and mass or bulk flow. After the coal has been pulverized, the movement of the coal, generally, is by a pneumatic system. Successful handling of a coal is a prerequisite of its successful use, for handling is the first part of its use. Continuity of flow and a uniformity in keeping with the load demands is imperative for desirable operating standards.

Treatment of Coal

Uniformity of the rate of handling required for satisfactory performance of a pulverized fuel plant focuses attention on the treatment of the coal for smoother and easier handling. This treatment may be of two general types: chemical or oil.

A goodly portion of the chemicals so employed includes compounds of chlorine, bromine, iodine, sulphur, oxygen and nitrogen with calcium, sodium, zinc, copper, tin and lead. Chemicals normally are applied in an amount equivalent to about 2 to 4 lb per ton of coal treated. Sometimes bulk may be brought about by the addition of dyed sawdust or grain hulls or of charcoal. Normally, the materials volatilize rather easily, or just the reverse may be true.

Due to the greater efficiencies with which the normal pulverized coal unit is operated, the flue gases must be correspondingly cooled, with the result that various acids or acid reactions may be formed within the air preheater, the economizer, the breeching, the induced draft fan or the smoke stack.

Corrosive action which may be encountered by the use of the chemicals eventually may do far more

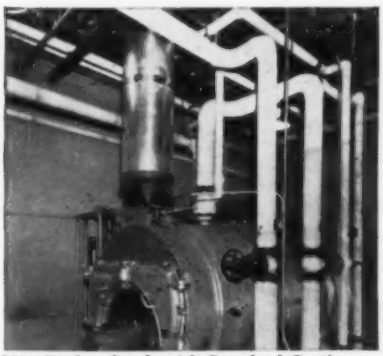
Low cost refractory stack outlasts steel

Low cost — The Van-Packer Industrial Stack is made of prefabricated sections for economy and easy installation. It costs no more than a steel stack, yet lasts substantially longer. Costs only a third as much as a brick stack.

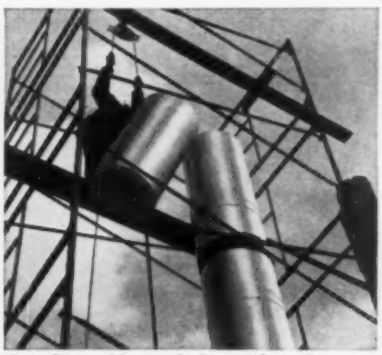
Refractory construction — Van-Packer Stack sections are centrifugally-cast of refractory material that will not corrode. Three-foot long sections come in 7 diameters from 10-inch ID to 30-inch ID to meet your requirements.

Needs no maintenance — Sections of the Van-Packer Stack are cemented one on top of another with acidproof cement, and secured with aluminum drawbands. Sections have an aluminum outer jacket that requires no maintenance.

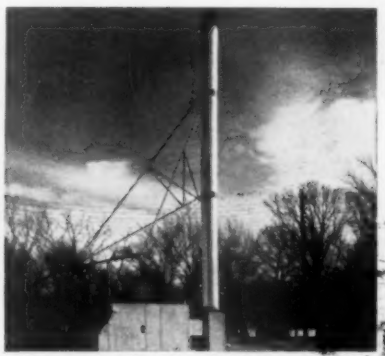
Available nationwide — The Van-Packer Stack is available through local Van-Packer Jobbers and Special Representatives. See "Chimneys — Prefabricated" in Yellow Pages, or write Van-Packer for Bulletin IS-32-59.



Van-Packer Stack with Standard Sections handles boilers and furnaces efficiently. Can be superimposed or floor supported.



Installing this stack is quick and easy. Three-foot sections are simply cemented atop one another with acidproof cement.



Van-Packer Stack with Hi-Temp Sections handles industrial incinerators with flue gas temperatures up to 2000° F.

Van-Packer PREFABRICATED REFRACTORY **Stack**

Van-Packer Company • Division of the Flintkote Company
P. O. Box No. 306, Bettendorf, Iowa • Phone: East Moline, Ill. 3-5288

Sweet's

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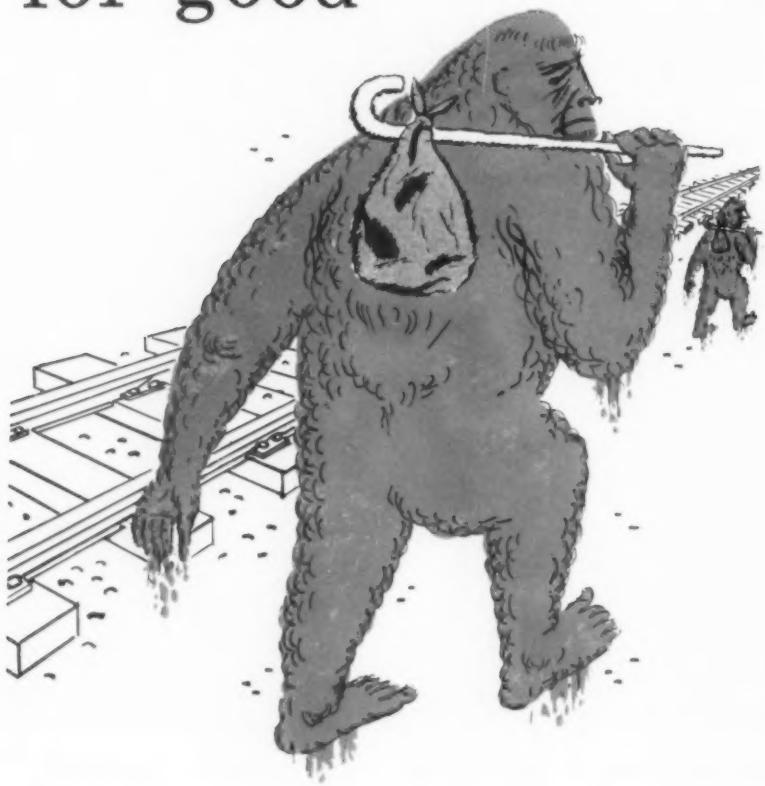
Algae's gone for good



Algae formations in condensers, spray towers, cooling ponds, reservoirs, air conditioning equipment and other water systems can cause costly problems if allowed to develop.

These problems can be solved, simply and economically, with HTH Granular, containing 70% available chlorine. Dry HTH Granular is free-flowing, dissolves quickly, and gives fast, effective algae kills. It can be applied easily and safely—no expensive equipment or specially trained personnel are needed.

For complete information on the use of HTH for algae control, write to:

OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

HTH® is a trademark 5791

For more data circle 544 on Post Card

Burning Pulverized Coal

continued from page 98

costly damage than the immediate benefits derived by the use of the chemical treatment. Also, the hygroscopic nature of the salts, or their ability to absorb and retain moisture, makes for an increased tendency for the coal to pack or bind in storage even though freezing tendencies may be improved.

Treatment of the coal with oil, especially if the oil used is of sufficient viscosity to require that it be applied hot, tends to give the coal particles a glaze coating, causing the shedding of the surface moisture. Since, too, the dust particles tend to become attached to the larger coal particles, the flow of coal is improved. Amount of treatment must be watched, but it appears that for coals of $1\frac{1}{4}$-in. Nutslack preparation or finer, the oil treatment will vary between $1\frac{1}{2}$ to 5 quarts of the oil per ton.

For some cleaned Cedar Grove seam $\frac{1}{4}$-in. by 0 Slack, approximately 3.5 quarts of oil per ton may be considered as the normal treatment. However, for very good handling 1.5 to 2.5 quarts per ton is quite satisfactory. Generally, it may be said that the physical characteristics of the coal, including cell structure and porosity of the coal particles, determine in a large measure the amount of treatment required. It would seem that the oil treatment might well be improved by the addition of a small amount of an oil-soluble silicone.

Cyclone-Type Burner-Furnace

Cyclone-type of coal burner and furnace method of burning coal is also the newest type, and while it is noted here under pulverized coal, to which it is related most closely, it is nevertheless not a truly pulverized coal system.

Coal fired is crushed to the point of passing through a 4 mesh screen. It is fired into a hollow drum or cylinder shaped furnace about 8 or 9 ft in diameter. Length of the cylinder is approximately equal to that of the diameter. Walls of this type of burner-furnace are a water wall arrangement of tubes. Center line of the drum is at a slight angle downward, front to rear. Gas or flame travel within this burner or cyclone furnace is essentially that of a horizontal spiral coil.

Heat release within the cyclone is extremely high, being from about 200,000 to about 850,000 Btu per cu ft per hour. Within the primary furnace the heat release is approximately 25,000 to 28,000 Btu per cu ft per hour. While undoubtedly a large portion of the coal burns in suspension, because of the spiral coil type of movement the basic characteristic appears to be that of a surface combustion type of reaction on a fuel or slag bed.

Slag discharge from the cyclone furnace and primary furnace to

GILSULATE® Pipe Insulation Digest

FOR UNDERGROUND HOT PIPES

Analyze costs of seven insulation systems

Case Tech chooses Gilsulate

When one of the nation's top technical schools selects your product after long laboratory and field tests you have a right to be proud.

We're doubly proud of Gilsulate: it's been chosen by Case Institute of Technology in Cleveland as the underground hot pipe insulation for its major expansion program—and for rehabilitation of all steam distribution systems on the campus as the need arises.

Case is only one instance of major Gilsulate installations at leading schools, colleges, training centers and other large institutional centers. You will also find Gilsulate protecting underground hot lines in every type of industry, in all parts of the country.

The trend is to Gilsulate. Write for complete details and learn why.

300-FOOT REPLACEMENT LINE going in at Case. Note forms around pipe to conserve Gilsulate.

GILSULATE IS THE SIMPLEST TO INSTALL of any underground hot pipe insulation. An illustrated wall chart, "How To Install Gilsulate," showing the 10 simple steps to follow, has been prepared. We will be glad to send you a copy on request.

How to select underground hot pipe insulation

There are at least 11 important points to look for in choosing insulation for underground hot piping systems. Users' experience with Gilsulate and other insulations under all and varied conditions proves that Gilsulate can out-perform all others. The 11 points are:

1. High resistance to both conductive and radiant heat flow.
2. Stable and non-corrosive in air, acid and alkaline soils, and salt water.
3. Good dielectric.
4. Moisture-proof and vapor-proof *without* jacketing or sealing.
5. Uses readily available materials both in manufacture and installation.
6. Easy and rapid to install, with a minimum of skill and effort.
7. Structural stability under vibration, dead and live loads, during shipping, storage, installation and operation.
8. Adaptable through a wide range of temperatures.
9. Allows pipe to expand and contract.
10. Allows system to be repaired and altered easily.
11. Allows piping leaks to be detected readily.

Gilsulate costs less per installed linear foot than *seven* different types of underground distribution systems, according to a report given by R. D. Hummel at the annual meeting of the National District Heating Association. Mr. Hummel is Manager, Division of Engineering, Yale University.

Based on installations of 1,000 feet of 8-in. welded steam line, and 4-in. welded return, Gilsulate costs $27 per linear foot, including the pipe, digging and insulation. The table below lists the systems compared, and costs.

System	*$Cost/ft.*
Gilsulate	27
Product A, with concrete fill	32
Tile conduit; pipe insulated with magnesia, and wrapped	32
Pipe insulated with magnesia and having metal jacket with protective coating	32
Reinforced concrete pipe over concrete slab, with wrapped magnesia insulated pipe	35
Precast slab envelope with magnesia insulated pipe within	42
Walk-through tunnel with magnesia insulation on lines	120

Here again is convincing proof that poured-in-place Gilsulate drastically cuts underground hot pipe insulation costs, with top corrosion protection and thermal efficiency. Gilsulate's high resin content, water-repellent properties, resistance to all corrosive elements normally found in soil, and high insulating value are unique. No wonder Gilsulate is the ideal—and most economical—solution to underground hot piping insulation problems!

Note: A complete account of Mr. Hummel's talk will be found in the Spring 1957 issue of PIPE INSULATION NEWS, available on request.

All of these items appeared in PIPE INSULATION NEWS. To keep abreast of money-saving hints and developments in underground hot pipe insulation, ask to be put on our mailing list.

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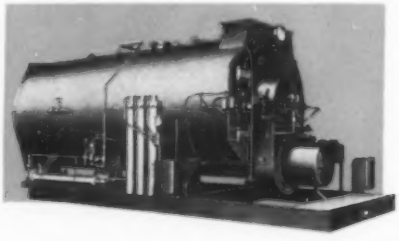

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Here's how H. D. Koblitz, Cleveland property management company, changed steam generators without interrupting steam supplied to 365,000 sq. ft. of plant area. On a balcony over the fire aisle, they installed 4 Cyclotherms while the old installation still operated. Then they dismantled the old boilers, putting 3 Cyclotherms in their place. A complete new installation, without one second's loss of steam!

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Burning Pulverized Coal

continued from page 100

which the former is attached or united is variously determined to be 80 to nearly 95 per cent of the total ash in the coal consumed. This results in a much cleaner emission of flue gases from the stack. The need for extensive and costly fly ash collection equipment is lessened.

Generally, the low ash-softening and fluid characteristics of the ash sought in coals suitable for the wet bottom or slag tap types of units are likewise sought for the cyclone furnace units. An ash with low iron content (under 30 per cent iron oxide) is desirable. Granular nature of the chilled molten ash particles makes it desirable for earth fills and for cinder block manufacture. Relatively small amount of loose fly ash may be absorbed with these same uses, where the large quantities of fly ash alone that might be collected from pulverized coal firing tend to become a problem.

Some of the coal characteristics sought for suitable application are:

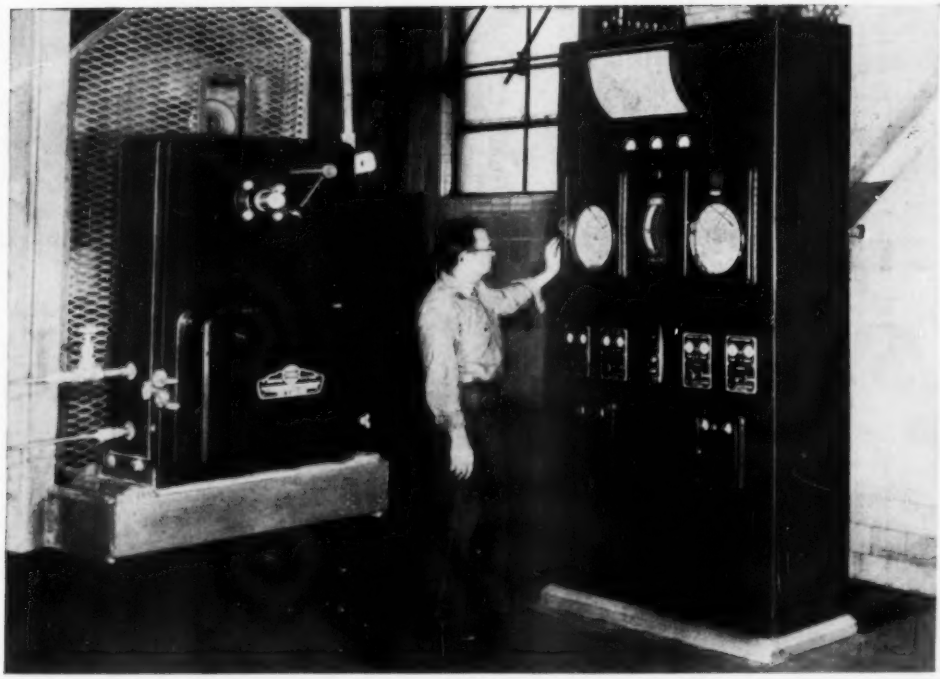
1. Coal should have a moisture content under 7 per cent. Coals over 7 per cent moisture requiring drying. This adds to the cost of the use of this type of equipment. This cost generally is between 20 to 30 cents per ton of coal. If the coals are not dried, additional labor may be required to get those coals to the boiler. It has been found, too, that the wet coals have attributed to the slagging.

2. Coals which have become oxidized in the seam or bed to the extent that the moisture-ash free heat value is under 14,500 Btu per lb have been found to cause excessive slagging, increased carbon loss, increased unit outage and, of course, increased operating and maintenance costs.

3. Generally, it is desirable that the fluid temperature of the ash should not exceed 2450 F. Usually it is desired that the ash-softening temperature be only about 2150 F, with the maximum at about 2300 F. Temperature range of the ash from the initial deformation through the ash-softening to the fluid condition is important. In some cases it appears that coals having fluid temperature up to 2550 F may be permitted. Care must be exercised in coal selection. Specifications of the ash fluid temperature may be such as to limit the selection of coals to a fairly narrow range. Otherwise, the semi-solidifying ash may present quite a problem in its removal.

Flame Characteristics

Flame characteristics and speed of reaction of the coal particles are closely related to the volatile content of the coal, to the length and volume of the flame, the luminosity of the flame, the fineness of pulverization and the erosive characteristics of the flame. THE END



This Bailey Control System helps cut fuel costs on a 70,000 lb per hr capacity 125 psi boiler in an industrial plant. Control drive in foreground regulates stoker.

How Bailey stretches your fuel dollar...

You can wring more energy out of a dollar's worth of fuel when you are getting optimum performance from your steam plant equipment. You get peak performance when Bailey Meters and Controls are on the job. They increase your plant efficiency.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

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You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

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Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

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A132-1

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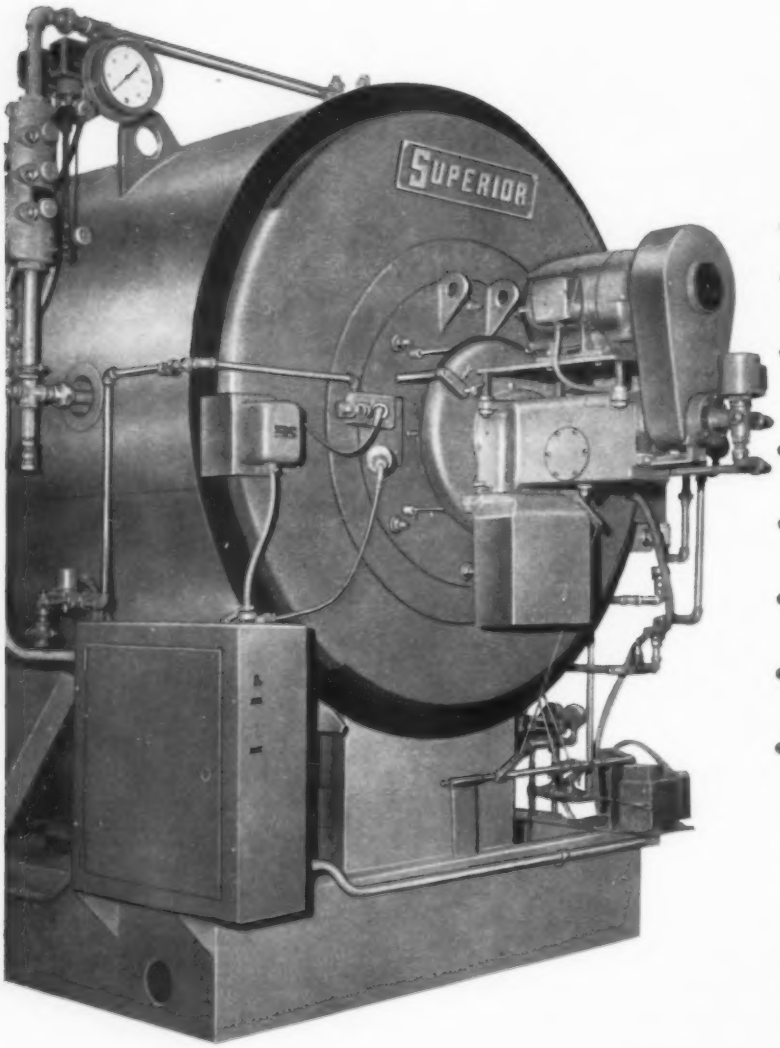

The Superior COMPACT boiler combines reduced over-all dimensions with rugged, practical boiler construction.

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- Fully automatic; firing oil, gas or both. Dependable rotary burner reduces maintenance and supervision. Insures fuel economy.
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- Completely insulated and jacketed. Insulation extends all the way round the main drum.
- High furnace, separated from bottom of boiler by tubes of fourth pass, is safely away from "danger zone" completely eliminating bagging and blistering of furnace which results when mud builds up between bottom of boiler and furnace.

11 sizes from 20 to 200 b.h.p. for pressures to 250 p.s.i. or for hot water operation. Other Superior fire tube units are manufactured in capacities to 600 b.h.p.

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PACKINGS, SEALS

201 Mechanical Packings — Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800 C. Packings for every industrial application are covered and a recommendation chart is included. The Belmont Packing & Rubber Co.

202 Packing Catalog — Catalog 54 contains literature on company's line of packings and gaskets to serve a variety of industrial needs. Among the items featured are metallic packings, fibrous packings, plastic packings, gaskets and sheet packing, as well as high-temperature anti-seize compounds. A section of engineering data and conversion tables is included. Felt Products Mfg. Co.

203 Mechanical Packings — Catalog P-210C contains 40 pp of detailed information on company's line of mechanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations and specification charts. Raybestos-Manhattan, Inc.

204 Mechanical Seals — Sealing systems for boiler feed pumps and other hot water services are described in Form S-230. Schematic boiler feed pump sealing arrangement is included, as well as other illustrative material. Crane Packing Co.

TUBING AND ACCESSORIES

205 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

206 Tube Expanders, Cutters — Catalog 81, 32 pp, contains specifications of company's line of tube cutters and expanders for fire tube and water tube boilers, condensers-coolers, heat transfer units, refinery still tubes, others. Also gives necessary information on operating accessories. Many excellent demonstrations of product application are included among the 300 illustrations provided, as well as tables of sizes, ordering tips and distributors. The Gustav Wiedeke Co.

207 Tube Expanders — Catalog 88, 119 pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, cata-

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log provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and includes charts of sizes. Thomas C. Wilson, Inc.

208 Tube Cleaners — Bulletin G-515 describes company's line of air, steam and water driven tube cleaners and accessories. Photos of the various types of cleaners are included, along with descriptive details and specification data. Elliott Co. — Roto Plant, Div. of Carrier Corp.

209 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in others. Revere Copper and Brass, Inc.

COAL AND ASH HANDLING

210 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features of the line and includes dimensions. American Pulverizer Co.

212 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

213 Jet Ignition Stoker — Information regarding company's jet ignition stoker is presented in Bulletin G-85. Rapid response to load change, ignition stability, efficient combustion, and a simple hydraulic drive are features described. Jet ignition stokers adapted to boilers in specific industries are shown and a typical fuel chart with comments and ASTM rank is also included. Babcock & Wilcox Co.

214 Spreader Stoker — Advantages and features of company's continuous ash discharge spreader stoker are detailed in this 24-pp bulletin. Illustrates and describes operation details, and includes diagrammatically illustrated specifications, schematic diagrams showing installations with various types of boilers, and photos of typical installations. Detroit Stoker Co.

VALVES, TRAPS AND PIPING

215 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

216 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp

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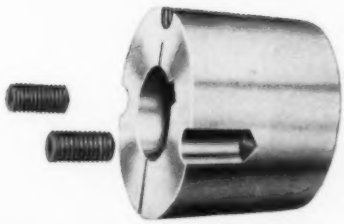

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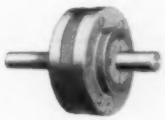
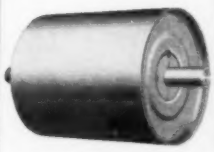
Change from sheaves to sprockets to couplings to conveyor pulleys				

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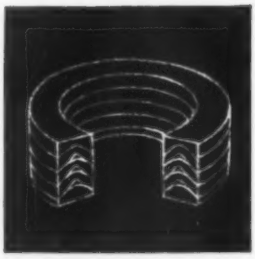

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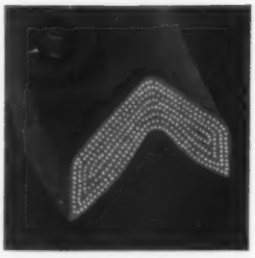

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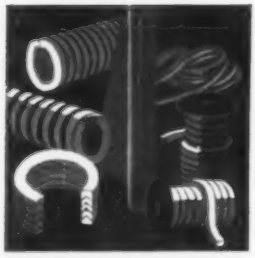

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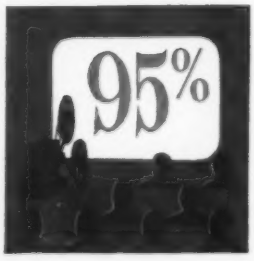

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Bulletin WH 851. Photos, drawings and curves supplement text, and test data is presented to show efficiency of company's silent check valves in water hammer control. Some typical installations are illustrated. The Williams Gauge Co., Inc.

217 Composite Valves — This 24-pp catalog, Form 186, features company's line of bronze, iron, steel and corrosion resistant valves. In addition to descriptions of component features, it contains photos, cutaway views and complete specifications. The Wm. Powell Co.

218 Check Valves — Twenty-pp Catalog 30A presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 2500 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

219 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

220 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

221 Industrial Valves — Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer butterfly valves, treaded butterfly valves, slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

222 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stock-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

223 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. Photos, drawings and diagrams amplify the text. The Henry Pratt Co.

224 Valve Digest — Form 197R is a valve catalog digest furnishing the latest coverage of the OIC bronze, iron, cast steel, forged steel, and lubricated plug valve lines in a condensed form. Valves are classified by type and pressure class, and illustrated; this edition also includes face to face dimensions for each size and type of valve listed. The Ohio Injector Co.

225 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of

Webster IDLERS FOR BELT CONVEYORS

Above photos show a portion of conveyor system at Philip Sporn Station of American Gas and Electric Service, Graham, West Virginia. Conveyors are equipped with Webster Idlers.

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company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

226 Impulse Steam Trap — Bulletin T-1742, 8 pp, describes a line of impulse steam traps designed for a variety of trapping requirements. Contains information on operation, materials and capacities and includes dimensional and specification data, as well as photos of typical installations. Yarnall-Waring Co.

227 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as repair. Armstrong Machine Works.

228 Insulated Piping — Bulletin 57-1, 24 pp, on prefabricated insulated piping systems, shows typical uses for Hel-cor pipe units for underground or overhead pipe systems. Also describes Utilidor conduits for protection of underground utility services. Sample specifications are given, along with conduit sizing charts. Ric-wiL, Inc.

229 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austenitic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

230 Flexible Hose, Bellows — Sixteen-pp Catalog 156 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specification of individual applications. Charts of the various metal-formed bellows and hose are provided. Flexonics Corp.

ELECTRICAL EQUIPMENT

231 Testing Instruments — Bulletin 19-58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, covering chief features, operating ranges, and applications. James G. Biddle Co.

232 Selecting Protective Devices — The Protection Handbook, 24 pp, is based on the 1956 National Electrical Code, and interprets this code into easily read form. It covers the selection of protective devices for electric circuits, motors, appliances and apparatus, and includes a list showing the size to use when ordinary fuse, Fustron dual-element fuse or Fustat is installed. All information is condensed. Fully

illustrated, book gives wiring diagrams, motor tables. Bussmann Mfg. Co.

233 Cable Troughs — This 12-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and many special fastening devices to save time and labor. Contains full instructions for installations, load charts, accessory items, some typical installations and full list of distributors. The Globe Co.

234 High-Power Batteries — Bulletin CP-538/55 covers company's line of Hi-Power batteries for use in the control-switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

PUMPS, COMPRESSORS

235 Controlled Volume Pumps — Bulletin 953, 24 pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water testing systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

236 Proportioning Pumps — Catalog 602, 8 pp, covers details and specifications of two mechanical and hydraulic drive metering and proportioning pumps, for precision pumping as low as 11 cc per min, and a chemical pump for systems requiring limited capacities. Advantages are enumerated and capacities and pressures tabulated. Hills-McCanna Co.

237 Solids Handling Pumps — Bulletin 121-A, 8 pp, describes a complete line of non-clog pumps for handling solids in suspension. Included are vertical, horizontal and close-coupled types used to handle liquid components of industrial processes, industrial waste, and for such pumping applications as water supply, drainage and sewage handling. Specifications are included. Aurora Pump Div., The New York Air Brake Co.

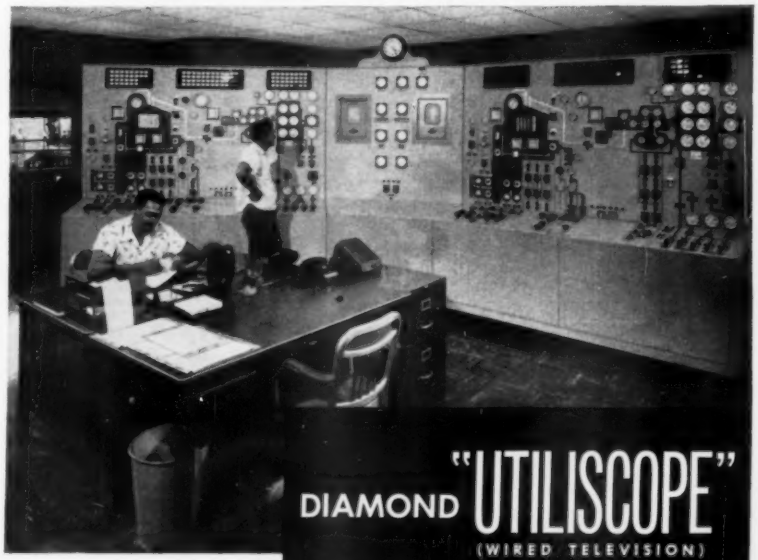
WATER CONDITIONING

238 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

239 Water Treatment — Bulletin 5000, 24 pp, explains the reason for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

240 Evaluating Steam Purity — Technical Paper 135, 88 pp, entitled "Con-

AUTOMATION IN POWER PLANTS



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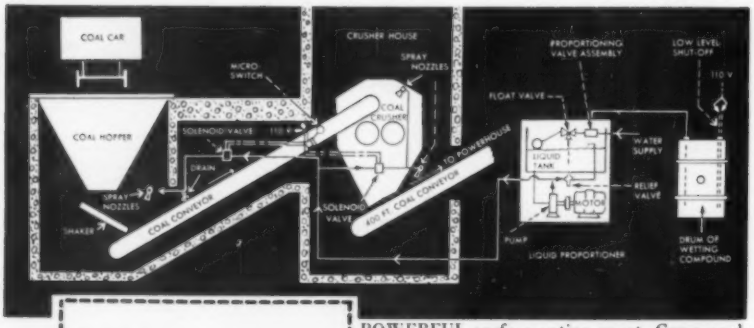

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ductivity vs Sodium by Flame Spectrophotometry In Steam-Purity Studies," presents results of laboratory and plant work to indicate that sodium is extremely valuable in evaluating steam purity. Performance curves are included in the paper. Betz Laboratories, Inc.

241 Valveless Filter — Operation of company's automatic valveless filter is described in this 8-pp illustrated bulletin. Applications and typical operating conditions are detailed and diagrams and photos are included. The Permutit Co.

242 For Boiler Protection — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine, and properties and handling of the material. Comprehensive operating data given. Olin Mathieson Chemical Corp.

243 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW-7. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

245 pH and Chlorine Control — The 13th (1957) edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

246 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization at flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

247 Cooling System Treatment — Bulletin C1 describes advantages of company's treatment for cooling tower systems with synergised polyphosphates. Details of the system are fully covered. National Aluminate Corp.

248 Cooling Water Treatment — Some aspects of cooling water problems are discussed in this bulletin on chemical treatment of industrial cooling water. Chemical treatments for scale prevention, corrosion prevention and algae and slime control are some treatment methods described. Western Chemical Co.

BOILERS, GENERATORS

251 Automatic Boilers — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air. Boiler Engineering & Supply Co., Inc.

252 Compact Generator — This bulletin describes a packaged water tube generator, company's Type DK, available in units for 8400 to 45,000 lb of steam per hour. Gives features, size and capacity data on these boilers which are designed to require less space than many water tube units. E. Keeler Co.

253 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room without extensive structural changes. Cyclotherm Div., National-U. S. Radiator Corp.

254 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features of the units. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

255 Steam Generators — Bulletin 55-1, 22-pp, describes company's products and services, including not only steam generators but also custom metal fabrication. There are many photos of boilers in various stages of assembly. Engineering drawings of boilers producing up to 500,000 lb of steam per hr on standard fuels are included, as well as illustrations of units for waste heat application and those designed to utilize refuse for fuels — wood chips, coffee grounds. The Wickes Boiler Co.

256 Steam Generators — Twelve-pp Bulletin PSG-2 contains design and construction details on company's package unit steam generator — a vertical, bent tube, longitudinally fired water tube boiler. Capacities, dimensions and weights are tabulated and drawings, diagrams and photos showing fabricating methods included. Henry Vogt Machine Co.

FUEL, BURNING EQUIPMENT

259 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

Postage-free cards for ordering catalogs are on page 105. You may also use the cards to order literature mentioned in the ads.

260 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

261 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other

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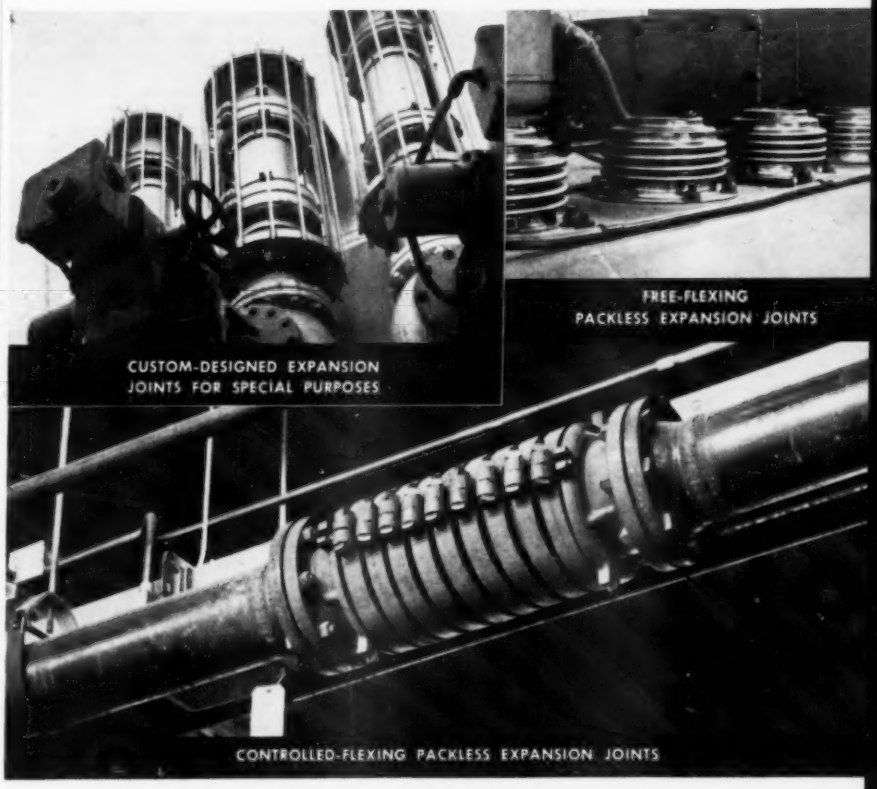
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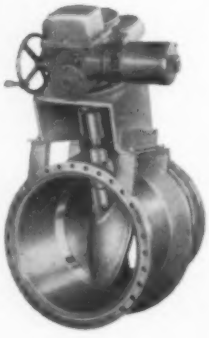

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furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

MECHANICAL POWER TRANSMISSION

263 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multicolor tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

264 Flexible Cushion Coupling — Bulletin A669, 12 pp, describes the Paraflex, a flexible cushion coupling, designed to automatically compensate for all combinations of misalignment and end float. Cutaway views and drawings are included, as well as coupling selection data and a table listing service factors for couplings. Dodge Mfg. Corp.

265 Self-Aligning Coupling — Form 273-M50 describes principles and features of company's all-steel, self-aligning coupling for shaft sizes up to 3⅛ in. Variations and modifications are illustrated and a table of coupling ratings and dimensions is included. Metal Products Div., Koppers Co., Inc.

REFRACTORIES, INSULATIONS

268 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-pp illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

269 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

272 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also general instructions, and information on use of Lumnite cement as a masonry mortar for laying brick. Sections are devoted to types of aggregates and data on weight, strength and thermal conductivity; a bibliography on refractory concrete is included. Universal Atlas Cement Co.

273 Condensed Refractory Data — Six-pp Bulletin 128A covers briefly this manufacturer's line of refractory products. Covers fire brick, silica brick, acid- and abrasion-resistant brick, cements and mortars, plastic fire brick, castables, coatings and insulating fire brick. Data given, including softening points, uses, etc., is presented in tabular form. Laclede-Christy Works, H. K. Porter Co., Inc.

275 Underground Pipe Insulation — This illustrated bulletin discusses the problems of underground pipe insulation and explains how company's insulation for

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hot underground pipes overcomes them. On-the-job photos illustrate ease of application; brief technical data are also included. American Gilsonite Co.

INSTRUMENTS, CONTROLS

276 Meters and Controls — Over 100 measuring, transmitting, receiving, recording and indicating instruments and control components, including those introduced within the last year, are described in the 8-pp 1957 edition of company's Bulletin G15-1. Applications, ranges, and detailed literature references are given for each product. Bailey Meter Co.

277 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, and explains operation. The Reliance Gauge Column Co.

278 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn casem chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in., pressures from 30 in. vacuum or a few ounces up to 100,000 psi. Manning, Maxwell & Moore, Inc.

279 Bi-Color Gage — Bulletin 1174 describes advantages of company's multiport bi-color gage made for medium and high pressure ranges. A cutaway view illustrating component features is included, as well as drawings and photos showing installation methods. Diamond Power Specialty Corp.

280 Pressure Regulators — Form 1011, on flow regulators, provides selection data with photos on three principal types of main valves and pilots. Also illustrated by line drawings are three suggested applications of regulators. A steam capacity table for the selection of main valve size is also shown. Spence Engineering Co., Inc.

281 Tube Expansion Control — Bulletin 64 describes a tube expansion control which automatically controls expansion by accurate measurement of torque. Advantages are detailed and specification data furnished. Airetool Mfg. Co.

282 Cooling Controls — Bulletin 710B describes company's self-powered cooling controls for compressors, stills, solvent coolers, degreasers, oil coolers, small engines, condensers, others. Includes hook-up sketches. Sarco Co., Inc.

OTHER EQUIPMENT

283 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

284 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this

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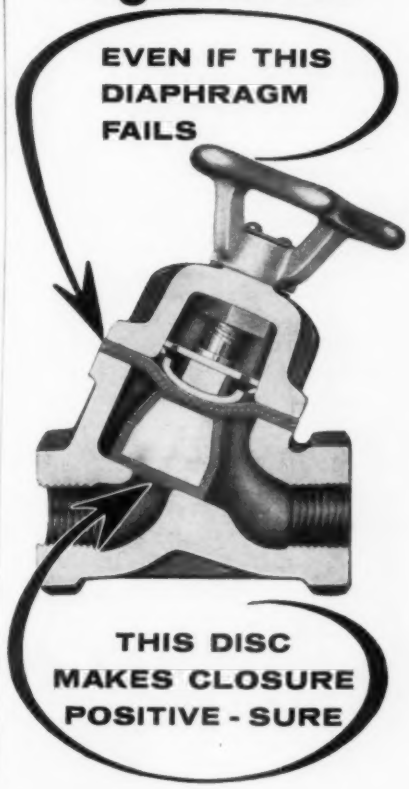

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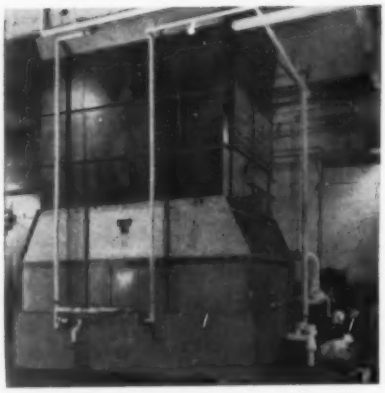

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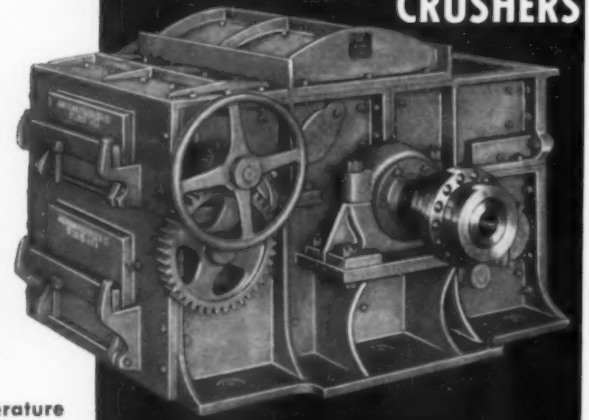

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collector is accompanied by collection efficiency and capacity nomographs. Tables give design data for six sizes, from three to 20 tubes. Research-Cottrell, Inc.

285 Electric Heating Units — Catalog 50, 50 pp, contains complete engineering data on electrical heating units and equipment, including strip elements, finstrip elements, tabular elements, cartridge elements, ring elements, immersion heaters, circulation heaters, radiant heaters, forced air duct heaters, unit heaters, hot plates and others. Includes photos, dimensional drawings, prices, standard rating tables, and specifications. Edwin L. Wiegand Co.

286 Engineering For Atomic Power — How $400 million in coin silver weighing 14,000 tons were borrowed from the U. S. Treasurer for use as electrical conductors, at the atomic energy plant in Oak Ridge, during the war when copper was scarce, is told in this 36-pp illustrated booklet. Describes the firm's role in the development of atomic energy and outlines its activities in peacetime applications. Stone & Webster Engineering Corp.

287 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

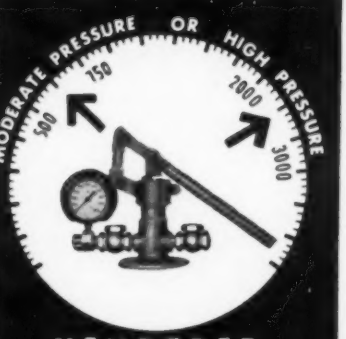
288 Equipment For Process Industries — Eight-pp Bulletin G-3 describes company's line of equipment for the process industries, including a conveying system for bulk materials, the Airveyor — a pneumatic conveying system, — the Airslide for transporting fine, dry materials without use of moving parts, as well as compressors and pumps, coolers and preheaters. Photos, cutaway drawings, and performance details are included. Fuller Co.

289 Low Pressure Heating Plant — Guide specifications for typical low-pressure commercial heating plants are presented in this 53-pp publication. Scope of guide specifications and basis of recommendations are detailed, and an index to specifications is given. Tabulated data are included along with drawings of typical boiler room, over fire air system, and electric boiler controls & stacks. Bituminous Coal Institute.

290 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Goodall Rubber Co.

291 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

292 Products and Services — Bulletin GSP-901, 24 pp, describes products and services of this company and its various divisions. Among products described



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are ring balance instruments, components for control systems, electronic devices, force measuring devices, water and steam treatment and testing equipment, chemical feeding equipment, chemical products for boiler water and steam conditioning, reagents, and a variety of products for water conditioning, food processing, paper processing, metal cleaning, others. Hagan Chemicals & Controls, Inc.

293 Aluminum Jacketing — Bulletin 530a describes company's line of aluminum weather-proof jacketing for insulated lines, towers, vessels and tanks. Application procedures are pictured and suggested specifications offered. Childers Mfg. Co.

294 Brine-Making Manual — Details on modern brine-making methods and equipment are presented in 12-pp Manual 135. Three types of brine-makers are described, as well as a wet salt storage system, and cutaway views and diagrams are included. Morton Salt Co.

295 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

296 Power Plant Equipment — Bulletin 1022-B, 12 pp, describes various types of power plant equipment, including combustion control, boiler feed water control, pressure reducing, desuperheating, and soot blowing. Photos and drawings illustrating equipment are included. Copes-Vulcan Div., Blaw-Knox Co.

297 Insulated Stack — This illustrated folder on company's pre-cast insulated stack contains complete product information, including advantages and description, specifications, suggested installation methods. Van-Packer Corp.

298 Belt Conveyor Equipment — Catalog 60-B, 15 pp, provides specialized data regarding the application of belt conveyors for the handling of materials, together with the listing of belt conveyor equipment. Included are charts and tables to assist in the selection of proper conveyor units and equipment for any specific service and location requirements. Webster Mfg., Inc.

299 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data rating tables, performance charts. Buffalo Forge Co.

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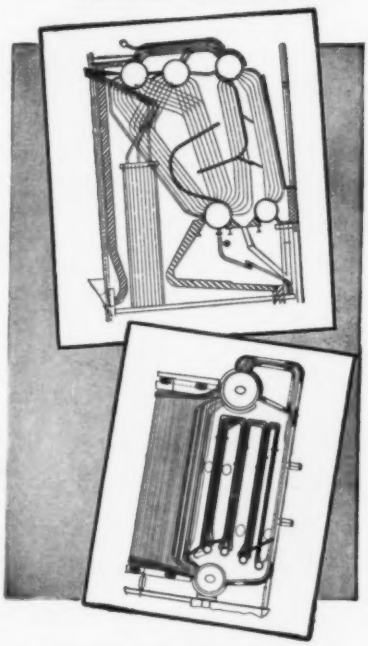

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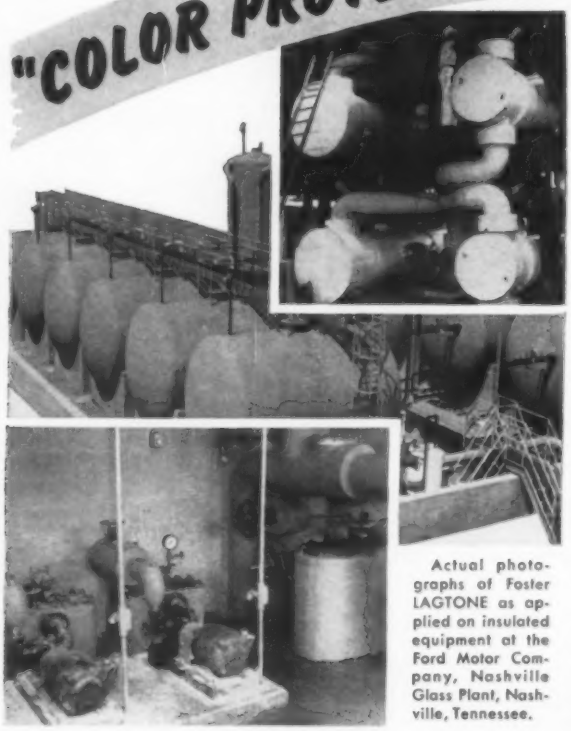

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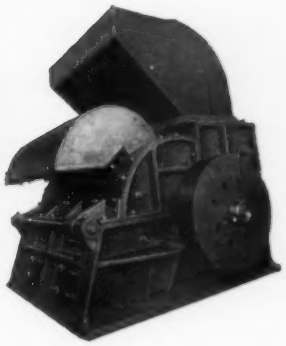

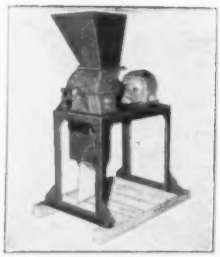

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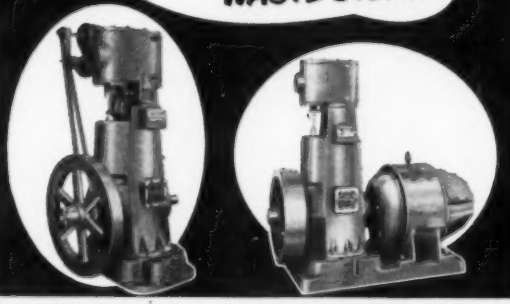

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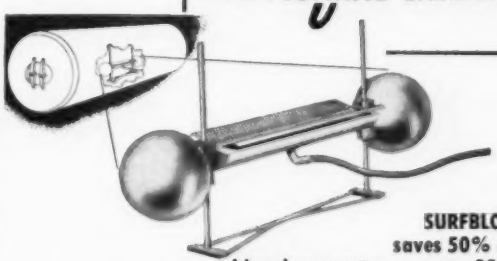

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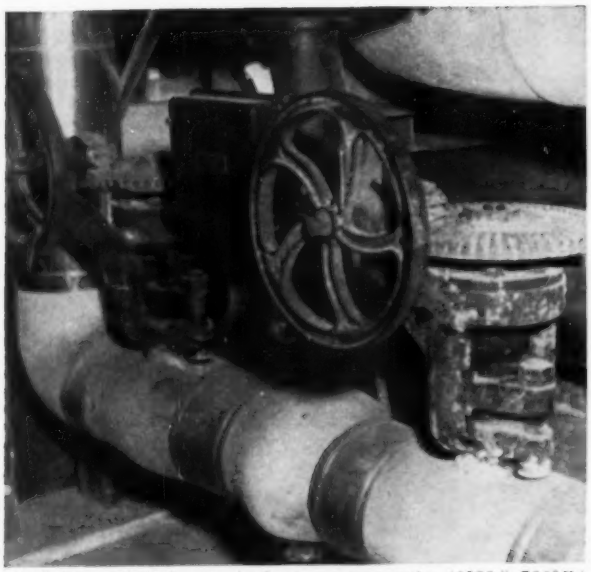
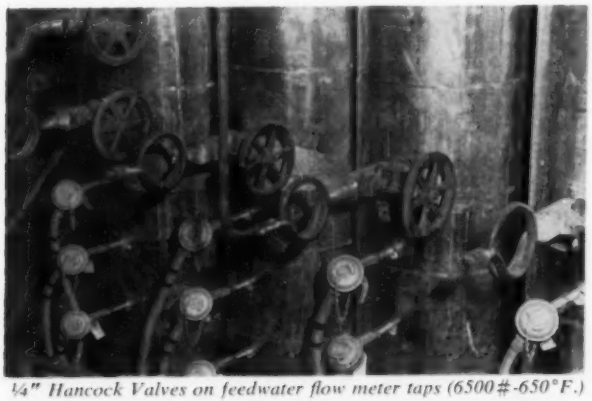


1¼" Hancock Valves in feedwater pump service (6500#-706°F.)



¼" Hancock Valves on feedwater flow meter taps (6500#-650°F.)

¼" Hancock Valves on main instrument lines (5000#-1150°F.)

VALVE DURABILITY
MATCHES
SUPERCRITICAL PRESSURES

Rated at 5000#-1150°F., Hancock Valves were selected for the new unit of the Philo Plant of Ohio Power Co. where boiler operation is at pressures and temperatures above the critical. *Stay-in-the-line durability* explains why design engineers and steam plant operators prefer these valves for feedwater service, drips, drains, vents and other piping.

Hancock Valves are easily serviced in the line. The bonnet is permanently welded to the body. No bonnet joint to leak. No seal weld to cut—no danger of damage to internal parts. The stellite seat is integral. No seat joint to leak. Seat refinishing is quick and easy with a power drill and reseating tool. The stellite disc is replaceable. The stem resists galling, erosion, thread wear; inhibited packing prevents stem pitting. No need for destructive "cheater" loading—handwheel operation is easy, closure positive against full rated pressure.

Protect personnel, plant and service to customers with durable Hancock Valves. Ask your nearby industrial supply distributor for complete details.

Sizes: ½" thru 2". OS&Y. Service Ratings: For all pressures up to 5000 psi at 1150°F. Weld Ends.

MAXWELL MM& MANNING & MOORE INC. TRADE MARK

114-58

HANCOCK STEEL VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data circle 570 on Post Card

Keep boilers on the line with

WILSON
TUBE MAINTENANCE TOOLS

1 Heavy-duty air driven tube cleaners are designed to deliver maximum power at the most efficient cutter head speeds while negotiating sharp bends, the Model ECT Air Cleaners are excellent for cleaning curved boiler tubes from 2½" to 4½" O.D.

2 Wilson Model 38 tube expanders are self-feeding and parallel expanding. They are of the single flare roll type. Available for tubes 1" O.D. to 4½" O.D. with various roll lengths for tube seats ¾" and up.

3 Flaring type expander 1" O.D. to 4½" O.D. tubes, ½" to 2" tube seats.

3A Long reach type expander 1" O.D. to 4½" O.D. tubes, 2½" to 5" tube seats.

4 This Wilson bevel gear drive is expressly manufactured to meet continuous and heavy duty service conditions. The one piece all steel body is extremely rigid and not subject to distortion. The maintenance of perfect gear alignment is assured with consequent long service life.

Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander catalog No. 88. TW-882

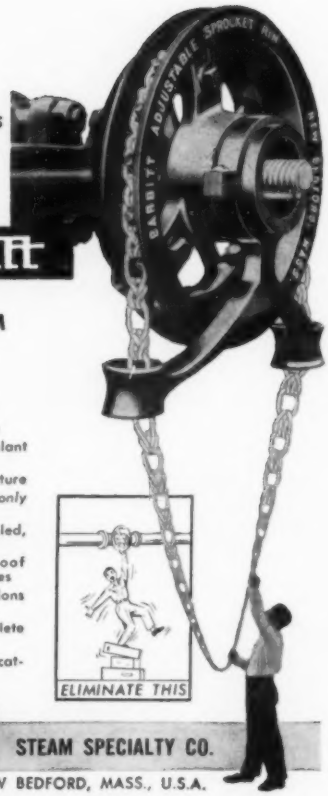
Representatives in principal cities

THOMAS C. WILSON, INC.
21-11 44th Ave., Long Island City 1, N. Y.
Cable address: "Tubeclean", New York

WILSON
TUBE CLEANERS • TUBE EXPANDERS

For more data circle 571 on Post Card

Safe Operation of Overhead Valves with a



Babbitt

Adjustable
SPROCKET RIM
with Chain Guide

- Simplifies pipe layout
- Fits any size valve wheel
- Easy to install and operate
- Operates any valve from plant floor
- Time and money saving fixture
- No maintenance, first cost only cost
- Packed, completely assembled, one to a carton
- Hot galvanized, rust-proof chain available for all sizes
- Easy to follow instructions with each unit
- Your supplier carries complete stocks
- Write for new descriptive catalog sheet and prices

Babbitt STEAM SPECIALTY CO.
4 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

For more data circle 572 on Post Card

For use wherever threaded connections are subjected up to 1800 °F. temperatures such as boiler, manhole, face plate studs, cylinder heads, and manifold studs or flange bolts on high temp steam lines and pumps.

Try C-5 and see why manufacturers, refiners and power producers have made it a part of their regular preventative maintenance program.

fel-pro C5 "HIGH-TEMP"

- ✓ Ends Seizing and Galling even up to 1800°F.
- ✓ Reduces Wrench Torque
- ✓ Ends Stud Breakage
- ✓ Permits Repeated Re-use
- ✓ Speeds Assembly and Disassembly
- ✓ Protects Stainless Steel at all Temperatures

1614BR

ANTI-SEIZE THREAD COMPOUND

C-5's exclusive colloidal copper formula separates mating metal threads and surfaces with cushioning, protective copper plating. C-5 prevents galvanic action and eliminates pitting even when dissimilar metals join. On mating metal surfaces, C-5 saves gaskets and countless man hours.

WRITE TODAY . . . For Your FREE Test Sample Can of C-5.

FELT PRODUCTS MFG. CO.
Dept. 78, P. O. Box 8809
CHICAGO 80, ILL.

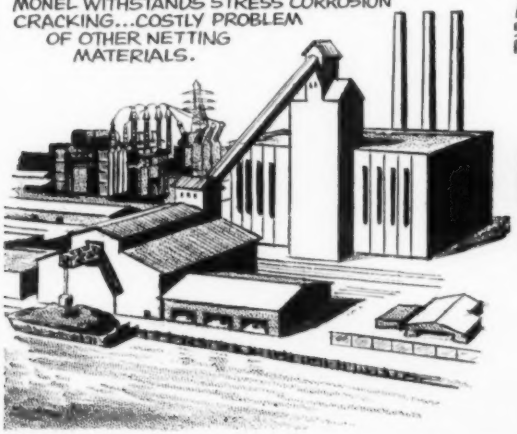
For more data circle 573 on Post Card

Chicken wire helps mechanic cut insulation costs

1930... GILBERT & BENNETT ENGINEER FINDS INSULATION MECHANIC WRAPPING CHICKEN NETTING OVER INSULATION OF OFFICE BUILDING BOILER. MECHANIC POINTS OUT THAT NETTING HOLDS INSULATION TIGHT, PREVENTS CRACKING. GILBERT & BENNETT TALKS IDEA OVER WITH LEADING INSULATING CONTRACTORS... DEVELOPS NETTING TO SUIT NEEDS OF CENTRAL STATIONS AND INDUSTRIAL POWER PLANTS

Takes POWER PLANTS by Storm

IDEA CATCHES ON... POWER PLANT MAINTENANCE ENGINEERS IN ALL PARTS OF COUNTRY USE MONEL HEX NETTING TO PROTECT AGAINST THE CORROSIVE ATMOSPHERES OF INDUSTRIAL AREAS... ATMOSPHERES LADEN WITH CORROSIVE FUMES. HERE MONEL .028" WIRE NETTING LASTS AT LEAST 2½ TIMES LONGER THAN GALVANIZED WIRE... SAVES ON REPATCHING AND REPAIRS. AND IN PRESENCE OF CORROSIVE CHLORIDES, MONEL WITHSTANDS STRESS CORROSION CRACKING... COSTLY PROBLEM OF OTHER NETTING MATERIALS.



Another new netting idea blows in... MONEL HEX NETTING

1944... INCO SALES ENGINEER IN HOUSTON AREA NOTICES SECTION OF INSULATION BLOWN LOOSE BY WIND... FINDS GALVANIZED NETTING RUSTED, BROKEN. HE'S TOLD IT LASTS 4 YEARS AT BEST... 6 MONTHS AT WORST. CURIOUS, HE CHECKS REINSULATION COSTS... LEARNS SCAFFOLDING ALONE MORE EXPENSIVE THAN MONEL* NICKEL-COPPER ALLOY HEX NETTING... AND MONEL WOULD CUT MAINTENANCE 50%. IDEA ADOPTED FOR INDUSTRIAL POWER PLANTS. FIRST INSTALLATION OF MONEL HEX NETTING NOW UP 12 YEARS!

GOT AN INSULATION BINDING PROBLEM?

YOU CAN GET THE INFORMATION YOU NEED... PLUS SAMPLES FROM **GILBERT & BENNETT**, GEORGETOWN, CONN.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street — New York 5, N. Y.

INCO TRADE MARK

*Registered trademark

INCO NICKEL ALLOYS

For more data circle 574 on Post Card

Precious Jewel of Industry's Future

"Black Diamonds" are America's most valuable resource for today and tomorrow! Only Bituminous coal can fully meet industry's needs for more electrical energy and more plant-power.

Convenient reserves of B&O Bituminous offer an unlimited supply of coals for every purpose, at low-cost. *Ask our man!*

LET OUR COAL TRAFFIC REPRESENTATIVES suggest a B&O Bituminous for your needs.

COAL TRAFFIC DEPARTMENT B&O RAILROAD
Baltimore 1, Md. LExington 9-0400

BALTIMORE & OHIO RAILROAD

Bituminous Coals For Every Purpose

LINKING 13 GREAT STATES WITH THE NATION B&O

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